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AEC-NASA SPACE NUCLEAR SYSTEMS OFFICE

NERVA RELIABILITY AND SAFETY ANALYSIS METHODS

VOLUME V - MANUFACTURING RELIABILITY METHODS

NERVA PROGRAM, CONTRACT SNP-1

JUNE 1972

AEROJET NUCLEAR SYSTEMS COMPANY
A DIVISION OF AEROJET-GENERAL

T/D/SNA -- 2017

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NERVA PROGRAM, CONTRACT SNP-1

JUNE 1972

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NERVA PROGRAM RELIABILITY PROCEDURE	NUMBER: R101-NRP-700	REVISION
	EFFECTIVE DATE: 30 September 1970	CATEGORY III
COMPONENT SPECIFICATION RELIABILITY REQUIREMENTS	SUPERSEDES: NUMBER: DATE:	
	APPROVED BY: J.M. Ramsthaler	

1.0 PURPOSE

This procedure will detail the component specification reliability requirements for suppliers to follow in order to achieve assigned reliability apportionment numerical values.

2.0 APPLICABLE DOCUMENTS

2.1 Reliability Program Plan, Data Item R-101
2.2 Subcontractor and Vendor Reliability Plan, NRP-701
2.3 Vendor Rating and Control System and Reliability Audit, NRP-702
2.4 Parts and Materials Data Selection and Control System, NRP-704
2.5 Identification and Control of Trend Characteristics, NRP-506
2.6 Development and Implementation of Trend Data Monitoring System, NRP-507
2.7 Analysis and Verification of Trend Characteristics, NRP-508
2.8 Reliability Data Collection and Reporting System, NRP-703
2.9 Component Failure Mode Analysis, NRP-301
2.10 Single Failure Point Reporting Analysis, Correction and Closeout, NRP-306
2.11 Reliability Apportionment, NRP-303
2.12 Failure Resolution Board Charter for Operation of the NERVA Program Failure Control System, M001-GOP03-W261al

3.0 POLICY

3.1 NERVA specifications will include reliability and trend data analysis requirements, assigned component reliability apportionment numerical values, and a useful life requirement. In addition, the specifications will require the methods of assessing the reliability, failure reporting and analysis and documentation of time and cycle data.

4.0 PROCEDURE

4.1 Requirements

4.1.1 The component specification will specify a total operating and non-operating life requirement.

4.1.2 The component specification will state a numerical reliability apportioned value for the total useful life and the associated environment.

4.2 The component specification shall require the following methods of assessment:

4.2.1 A detailed Failure Mode Analysis (FMA) will be performed per NRP-301. The FMA shall identify mechanisms of failure in order to assure that proper analysis or testing has or will be conducted to evaluate the mechanism. The FMA provides the basis for screening the critical failure modes which will be subjected to a probabilistic design analysis for assessment.

4.2.2 Trend Data Characteristics will be identified, reported and analyzed per NRP-506, 507 and 508.

4.2.3 Single Failure Points (SFP) shall be identified, reported, analyzed, corrected or closed out per NRP-306.

4.2.4 A preliminary ranking and apportionment of the component reliability allocation to the detailed piece part level shall be provided per NRP-303.

4.2.5 Assessment at the piece part level using analytical methods should follow the guide lines of the NRP-400 series procedures.

4.2.6 Assessment by testing will generally require the following:

(a) Use of statistically designed acceptance testing in order to estimate the expected mean and variance of each measured response variable. This requires an examination of the expected flight environments and their levels which will affect the response variables of interest. In addition, estimates are required of the precision and accuracy of the test instrumentation used in measuring the response variable, the extent of the interactions that can be expected among the imposed environments, and the expected repeatability of the response variables.

(b) Determination of the functional relationship between measurable response variables. This requires an analysis of how shifts in one response variables effect the other response variables. A detailed failure mechanism may assist in this determination.

(c) Definition of the boundaries of each response variable, outside of which, external compensation is required to prevent engine system failure. For response variables where continuous measurements during a test are available, estimates of the mean and variance may be derived from each simulated thrust cycle. For response variables with single data measurements per test, the results of several successive tests may be grouped to provide estimates of mean and variance.

(d) Determination of the probability of not exceeding the limits on each response variable. Combine the probabilities using a component math model which depicts the response variable relationships.

(e) Acceptance of the design if the part is more reliable than the reliability requirements and a redesign if the part does not meet the reliability requirement.

(f) Definition of a qualification test program which will evaluate component ability to meet the useful life and maximum environmental exposure. These tests verify changes in probability of meeting the engine limits as a function of time or cycles. Changes in reliability as a function of time or cycles would be indicated by shifts in means and/or variance. More than one mission duty cycle per component may be required in order to statistically define these shifts.

4.3 During development, acceptance or qualification testing where a failure occurs, a Departure Report shall be generated and transmitted to ANSC Failure Resolution Board (FRB) Secretary. In addition, a Failure Analysis Report with the corrective action will also be conducted and submitted to the FRB Secretary per M001-GOP03-W261a1.

4.4 Detailed time and cycle records shall be maintained for any parts subjected to functional tests. The records shall be identified by part number and serial number of the part undergoing the test, test type and date. These records will be forwarded to ANSC Reliability in a timely manner as specified in NRP-703.

5.0 <u>RESPONSIBILITY</u>

5.1 Systems Engineering will be responsible for defining the design requirements consistent with system operation.

5.2 Reliability will assign component reliability apportioned numerical values, will assist the designer in establishing methods of reliability analysis and statistical test planning, and will assure that the reliability requirements and methods of assessment are incorporated in the specification.

5.3 The cognizant component design engineer is responsible for the assessment of the reliability of the component and proper analysis of all failures. In addition, the design engineer is responsible for those Procurement documents specifying the methods of assessment which will be performed by the vendors.

5.4 Quality Assurance is responsible for documentation of failures and time and cycle recording.

NERVA PROGRAM RELIABILITY PROCEDURE	NUMBER: RJ01-NRP-701	REVISION
	EFFECTIVE DATE: 30 September 1970	CATEGORY III
SUBCONTRACTOR AND VENDOR RELIABILITY PLANS	SUPERSEDES: NUMBER: DATE:	
	APPROVED BY: [signature]	

1.0 SCOPE

This document sets forth guidelines for subcontractors and vendors of the NERVA prime (ANSC) and major subcontractor (WANL) who are required to prepare reliability plans. The requirement for this document is established in R-101, Reliability Plan.

2.0 APPLICABLE DOCUMENTS

2.1 Data Item R-101, Reliability Plan

2.2 NRP-700, Component and Procurement Specification Reliability Requirement

2.3 NERVA Program Procedure, m001-GOP03-W261al, Failure Resolution Board Charter for Operation of the NERVA Program Failure Control System.

2.4 Data Item P-017, Quality Control Plan

3.0 POLICY

3.1 General

NERVA engineering is responsible for ensuring that the reliability of system elements obtained from subcontractors meets the reliability requirements of the engine system. ANSC and WANL Reliability is responsible for ensuring that all subcontractors and vendors perform the required reliability activities delineated in R-101.

3.2 Suppliers to ANSC and WANL Requirements

All elements of the NERVA engine system, designed and built to ANSC and WANL requirements by a subcontractor, shall have applicable numerical reliability requirements and the methods of demonstrating compliance to these requirements included in a specification covering the design and performance requirements for that item. Each supplier shall develop reliability methods and procedures which shall comply with the specification requirements herein, and obtain ANSC or WANL Reliability approval prior to fabrication of the first article. The method to be followed in determining these requirements is outlined in NRP-700.

3.3 Suppliers of Items Fabricated to ANSC and WANL Designs

For elements of the NERVA engine subsystem, fabricated to designs furnished by ANSC or WANL, the design reliability is an ANSC or WANL Reliability responsibility. The supplier shall be responsible for providing assurance that his end product satisfies the reliability requirements specified in the purchase order. Reliability shall assure that the purchase order imposes the reliability and failure reporting requirements.

3.4 Suppliers of Standard Parts, Commercial Parts and Materials

Reliability shall be responsible for reviewing design documents prior to release to ensure that standard parts, commercial parts and materials are selected for use in the NERVA engine system on the basis of proven qualification of each part/material for its application(s). When adequate commercial specifications do not exist (as determined jointly by Reliability and Engineering) specifications shall be prepared for any part or material used in the NERVA engine system. Specifications shall include applicable reliability, mission and packaging requirements.

Where adequate applicable qualification data are not available, Engineering shall design and monitor the conduct of qualification tests with Reliability review on the materials and parts. The qualification test shall be designed to establish the test article's adequacy in meeting specification requirements and to develop acceptance test criteria. Qualification status of parts and materials shall be reported in the qualification status list prescribed in R-101.

All material and part specifications and test plans for parts proposed for qualification testing shall be submitted for SNPO-C review prior to release.

4.0 PROCEDURES

4.1 Control of ANSC and WANL Reliability Program

Control of the WANL Reliability Program will be as specified in Reliability Plan, R-101, and as indicated below.

4.2 Control of Supplier's Designing and Building to ANSC Requirements.

4.2.1 Design Requirement Specifications

ANSC or WANL reliability, as applicable, will provide the reliability requirements for supplier end items. This will include a numerical statement of the reliability to be demonstrated and a statement of the minimum reliability test and analysis program which must be satisfactorily performed to demonstrate product adequacy. The program requirements will be defined by reference to design and performance specifications. The ANSC Reliability Manager or his designee will review all applicable design documentation (drawings, specifications, etc.) prior to final approval by ANSC Reliability to assure that the reliability and demonstration requirements are adequately and properly stated.

4.2.2 Supplier's Reliability Plan

Supplier reliability plans, where required, will be submitted for Reliability review and approval prior to fabrication. Changes to supplier plans will be negotiated and formal approval forwarded via the cognizant ANSC or WANL buyer. Typical subjects to be covered in the plan are enumerated as follows:

a. Relationship of Program Elements to the Reliability Program

b. Program Scope and Requirements

c. Reliability Data Item Requirements

d. Management for Reliability

e. Design-Reliability Methodology

f. Probabilistic Design Analysis and Reliability Prediction (failure mode analysis, failure-probability, modeling, predictions, methods)

g. Supporting Reliability Analysis (apportionment, materials selection, parts application, data, maintainability, training)

h. Testing, Reliability Evaluation and Manufacturing Control (statistical test planning and test plan review, trend data, failure reporting, analysis and corrective action and assessment)

4.2.3 Supplier Progress Reports

When required, periodic progress reports will be reviewed by Reliability and comments forward to the cognizant buyer for transmittal to the supplier within five working days.

4.2.4 Monitoring the Supplier's Program

Reliability will furnish Quality Control and Purchasing with a listing of significant design features, along with development, qualification or acceptance tests, manufacturing process, etc., which have particular reliability significance, so that the assigned ANSC Supplier Quality Representative (SQR) may give such items the necessary attention at the supplier's facility.

4.2.4.1 Failure Reporting, Analysis and Corrective Action

Failure reports originated by suppliers will be reviewed by NERVA Reliability to evaluate the analysis and corrective action to assure that the reliability of the supplier's end item will not be degraded. FRB will approve all corrective action prior to implementation. When necessary, Reliability will negotiate through the cognizant ANSC buyer to impose additional requirements or additional corrective action to improve or restore the reliability of the supplier's product. (Refer to paragraph 2.3)

4.3 Control of Suppliers of Standard Parts, Commercial Parts and Materials

4.3.1 During review of design documents prior to Reliability approval, the cognizant Reliability engineer will aid in ascertaining that standard parts, commercial parts, or materials specified therein, have been qualified for the intended use. Unqualified parts/materials will undergo a qualification program to satisfy the requirements of paragraph 3.4.

4.3.2 Reliability will review all qualification test data to ensure that the item under test will not degrade the reliability of the assembly, component or system in which it will eventually be used.

NERVA PROGRAM RELIABILITY PROCEDURE	NUMBER: R101-NRP-702	REVI.
	EFFECTIVE DATE: 30 September 1970	III CATEGORY
VENDOR RATING AND CONTROL AND RELIABILITY AUDIT	SUPERSEDES: NUMBER: DATE:	
	APPROVED BY:	

1.0 PURPOSE

The procedure will describe vendor reliability pre-evaluation techniques, required vendor reliability control systems, and formal and impromptu vendor reliability audit systems. The requirements for this documents are set forth on Data Item R-101, the Reliability Program Plan.

2.0 DOCUMENTS

2.1 Data Item R-101 Reliability Program Plan

2.2 NRP 700 Component and Procurement Specification Reliability Requirements

2.3 Data Item P-017 Quality Control Plan

2.4 NRP 701 Subcontractor and Vendor Reliability Plans

3.0 POLICY

3.1 NERVA reliability is responsible to ensure that NERVA system elements received from subcontractors meet the reliability requirements of the NERVA engine system. This shall include the nuclear subsystem contractor.

3.2 The reliability system of all subcontractors shall be evaluated by ANSC reliability, consistent with the level of engineering effort, prior to placement of contracts for NERVA system elements.

3.3 During the course of a subcontractors activities on a contract for a NERVA system element, a reliability control system will be conducted consistent with the level of engineering effort.

3.4 A system of formal and impromptu audits of a subcontractor will be conducted consistent with the level of engineering effort required.

4.0 PROCEDURE

4.1 Pre-evaluation of candidate subcontractor Reliability

4.1.1 Evaluation of candidate subcontractors shall be based upon records of reliability performance, existence and adequacy of reliability procedures and, as necessary, an on-site survey of the supplier's reliability system.

4.1.2 Results of the evaluation shall be documented and provided to the NERVA Prime and Subcontractor Administration for use in selection of subcontractors, and will be available to SNPO-C for review.

4.1.3 A candidate subcontractor shall have an identifiable and functioning reliability effort.

4.1.4 The physical plant of the candidate subcontractors shall reflect the effective influence of a reliability system.

4.1.5 The candidate subcontractor shall have qualified reliability personnel in adequate numbers to perform the reliability function required.

4.1.6 The failure reporting, analysis and correction system shall be subject to approval by ANSC reliability.

4.1.7 An internal reliability auditing system is required. Results of audits shall be available. Necessary corrective efforts and results shall be documented.

4.1.8 An effective vendor reliability rating, control and audit system shall be in effect.

4.2 Control of Subcontractor Reliability

4.2.1 A reliability plan is required and shall be subject to approval by ANSC reliability.

4.2.2 Periodic reliability progress reports to ANSC reliability are required.

4.2.3 The subcontractors reliability program will be monitored routinely by the assigned ANSC supplier quality representative.

4.2.4 An ANSC reliability representative shall have the right to attend but not participate in subcontractor ERB/MRB/FRB meetings.

4.2.5 Reports of analysis of reliability problems shall be submitted. A specific report may be requested by ANSC reliability. The results are subject to approval by ANSC reliability.

4.2.6 Changes to reliability procedures, organization, program plan and physical plant concerned shall be subject to approval by ANSC reliability.

4.2.7 Formal or impromptu reliability audits may be conducted by ANSC reliability in accordance with Section 4.3.

4.3 Subcontractor Reliability Audit System

Formal or impromptu reliability audits may be held of the subcontractors reliability program by ANSC reliability provided reasonable notice is given the subcontractor. Audits may evaluate adequacy of the following if required:

4.3.1 The reliability program plan.
4.3.2 Implementation of the reliability program plan.
4.3.3 Reliability progress reports.
4.3.4 The failure reporting, analysis and corrective action system.
4.3.5 The reliability organization.
4.3.6 The internal reliability auditing system.
4.3.7 The supplier reliability rating, control and audit system.
4.3.8 Reliability procedures.
4.3.9 Reliability contributions to and approval of test planning including statistical techniques.
4.3.10 Reliability apportionments, assessments and predictions.
4.3.11 Reliability mathematical modeling.
4.3.12 Reliability inputs to specifications.
4.3.13 Materials properties determination with consideration of statistical distributions.
4.3.14 Reliability data acquisition system and historical data records.
4.3.15 Determination and records of failure rates.
4.3.16 Reliability input and influence upon design.
4.3.17 Reliability contributions to trade studies and redundancy studies.
4.3.18 Part and materials application.
4.3.19 Safety study support including hazard analysis and fault tree analysis.
4.3.20 Computer modeling of reliability problems.
4.3.21 Reliability training program including design reliability techniques.
4.3.22 FMECA/FMA studies.

NERVA PROGRAM RELIABILITY PROCEDURE	NUMBER: R101-NRP-705	REVISION
	EFFECTIVE DATE: 30 September 1970	CATEGORY III
RELIABILITY DATA COLLECTION AND REPORTING SYSTEM (REDCRS)	SUPERSEDES: NUMBER: DATE:	
	APPROVED BY:	

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1.0 PURPOSE

A central reliability data file has long been recognized as being essential to realistic assessment of current project reliability levels. The need for support to an effective closed loop failure reporting and corrective action system is paramount to diminish potential cost impact. In addition, the reliability data file provides an invaluable source of facts to support Reliability/Design Methodology.

The purpose of this procedure is to provide the methods by which the reliability data collection and reporting system (REDCRS) shall effect the accumulation, storage and dissemination of reliability data in the NERVA Program. It delineates the responsibilities for Engineering, Manufacturing, Quality Assurance, Test Division and other space systems support groups.

The requirement for this procedure is set forth in Data Item R-101, The NERVA Reliability Program Plan.

2.0 APPLICABLE DOCUMENTS

2.1 NERVA Reliability Program Plan, Data Item R101

2.2 NERVA Product Assurance Program Plan, Data Item P-017

2.3 Reliability Allocations, Assessments, and Analysis Report, Data Item R-202

2.4 NERVA Trend Data Implementation Plan 785C-0742.

2.5 Failure Summary Reports, AFSCM/AFLCM 310-1 R-105.

2.6 Single Failure Point Reporting, Analysis Correction and Closeout, Procedure NRP-306.

2.7 Glossary of Reliability Terms, Procedure NRP-307.

2.8 Reliability Review of Test Plans, Procedure NRP-501

2.9 Failure Analysis and Corrective Action, Procedure NRP-504

2.10 Identification and Control of Trend Characteristics, Procedure NRP-506

2.11 Development and implementation of Trend Characteristic Monitoring Systems, Procedure NRP-507.

2.12 Analysis and Verification of Trend Characteristics, Procedure NRP-508.

2.13 Component and Procurement Specification Reliability Requirements, Procedure NRP-700

2.14 Subcontractor and Vendor Reliability Plans, Procedure NRP-701

2.15 Parts and Material Selection and Control System, Procedure NRP-704

2.16 Reliability Test and Evaluation Plan, Data Item R-106

2.17 Test Reports, Data Item T-119

2.18 NERVA Program Failure Control System (FCS), Data Item M-001

2.19 NERVA Data and Document Management Control Plan. Data Item C-100

2.20 NERVA Configuration Management Plan, Data Item C-018

3.0 POLICY

3.1 A NERVA REDCRS will be developed and maintained by the prime contractor and the principal subcontractor. The REDCRS will be established in conjunction with the quality assurance data book and will be a satellite subsystem of the NERVA data management system. The REDCRS will be instituted coincident with the approval of this procedure.

3.2 The REDCRS will develop the rationale for the structuring of a large dynamic data base in the assimilation of experience in design, manufacturing, test, flight, and checkout of the engine hardware and supporting equipment.

3.3 The major elements of the REDCRS will assist an inquirer in defining his information needs as set forth in this procedure and the Reliability Data Index in order to provide management with supporting evidence in decision making.

3.4 A repertoire of generalized system operations will provide the REDCRS with the capability to modify data elements and its descriptive parameters to accomodate new data items or relationships in adjusting to changing requirements and operational experience.

3.5 The REDCRS staff will assess the precise data items needed and the mechanism for retrieving selected data to meet on-demand requirements.

3.6 A computerized data file will provide REDCRS with the capacity to show interrelationships among the variety and complexity of reliability data items through an automated data input, storage, processing, retrieval and output system developed by software methods.

4.0 DEFINITIONS

4.1 AVCO Failure Rate Data

The failure rate data developed by AVCO Corporation of Wilmington, Massachusetts for all types of components in efforts of advancing reliability standards in predictions and assessments.

e.g.: The REDCRS provides Reliability Engineering with the lower, mean and upper limit failure rate of servo motors in failures per million hours.

4.2 Configuration and Traceability Data

A Configuration and Traceability (C & T) List defines the "as built" configuration of hardware to be delivered or tested and incorporates a listing of replaced items by part name, part number and serial number identifying the relationship of all parts to the conformance with the configurations required by the Engineering Parts List (EPL/CEPL).

e.g.: An indentured Engine Parts List identifying by part and drawing number, the part name, quantity, part serial/or lot number, drawing change letters and engineering orders to which detail parts, subassemblies, and the assembly were manufactured with reasons for replaced items such as: limited life expended, replacement due to change letter, part failed during operation or test with applicable Failure Analysis Report Number.

4.3 End-Item

A combination of parts, assemblies, or attachments, which are integrated to form an equipment that accomplishes a specific function when utilized. The supplier's end item will be identified upon completion of Engine PDR, or as mutually agreed upon by ANSC and AEC-NASA;

e.g.: An end-item is complete within itself, delivered as a unit, and classified as such for purposes of separate manufacture, procurement, drawings, specifications, storage, issue, maintenance or use.

4.4 End Item Acceptance Data Package

Documentation required for the acceptance of each end item compiled from engineering release drawings, test records, reliability failure history and time/cycle records, specification references, and quality control verified fabrication and inspection records;

e.g.: Records of operating time/cycles of an individual data package as part of the end item data package for each system tested reflecting both accrued operating time and/or cycles and remaining useful life.

4.5 Failure Rate Data

Failure Rate Data (FARADA) is a composite data file of variable number of failure probabilities as derived from the number of component failures in a population divided by the number of unit attempts;

e.g.: Unless indicated otherwise, the "Failure Rate" of a component is given in failures per million parts-cycles, -hours or -trials.

4.6 Failure Rate Data Program

The Failure Rate Data (FARADA) Program is an inter-agency sponsored effort to promote and implement the exchange of failure and failure mode data on parts/components generated during performance demonstration testing. The FARADA Program is administered by the FARADA Information Center at the Naval Fleet Missile System Analysis and Evaluation Group, Corona, California;

e.g.: The REDCRS FARADA Coordinator is cognizant of all incoming program material, handbooks, revisions, format changes, and is conversant with the data contributed by NERVA Reliability.

4.7 Interagency Data Exchange Program

The Interagency Data Exchange Program (IDEP) is a cooperative government activity created to provide automatic interchange of parts/components test data among government contractors and agencies for the purpose of reducing duplicate expenditures in the selection and testing of non-standard parts for improving system reliability. It is sponsored by the Army, Navy, Air Force, NASA and CAMESA in a coordinated effort for promoting high reliability contractor specifications on parts;

e.g.: The REDCRS supplies NERVA Reliability and Design Groups with supporting evidence in parts-use justifications for NERVA Design inquiry requirements.

4.8 Non-Operational Limited Life Items Records

Records containing information relative to the remaining useful life of all non-operational limited life items contained in an end item indicating unit total life, installation date and replacement due data with proper identification including next higher assembly;

e.g.: Potting compound in the electrical connector assembly of the valve and actuator assembly systems could produce a limited storage life.

4.9 Operating Cycles

The number of times an item completes one set of events or phenomena recurring within the same sequence of operation;

e.g.: On-Off, Open-Closed sequences or portions thereof.

4.10 Operational Cycle

The initiation and establishment of new conditions followed by a return to the conditions that prevailed at the beginning of the cycle which may result in one or more stress cycles;

e.g.: Start-up and Shut-Down are a cycle.

4.11 Operational Data

Copies of Acceptance Test Data Sheets reflecting variable acceptance test results and the approved acceptance test procedures;
e.g.: Valve open and close response times recorded during acceptance testing while in a test fixture or next higher assembly.

4.12 Operating Time

A period of time measured in hours, minutes or seconds that an item is utilized functionally, either in a standby or operational condition;
e.g.: The period during which power is applied to an item and the item is performing its function in partial or full capacity.

4.13 Parts Reliability Information Center/Apollo Parts Information Center

The NASA sponsored Parts Reliability Information Center and Apollo Parts Information Center (PRINCE/APIC) stores and disseminates information on parts and materials having application in various Aerospace and Defense related projects to service engineers in such fields as Design, Quality Assurance, Reliability and Testing;
e.g.: The REDCRS forwards to Reliability Engineering Unsatisfactory Condition Reports on metallic casings by part class.

4.14 Shelf Life

The degradation of basic materials with time and environment under no operating stresses constitutes a measure of action to be taken at a specified point in time;
e.g.: Upon expiration of a specific maximum period of age after the cure date of a material part, would require the discard of this part from storage shelves to avert installation into an assembly.

4.15 Temperature Cycles

A temperature-difference fluctuation producing a non-uniform distribution of temperature or differing thermal coefficients of expansion;
e.g.: A condition in which the alternating temperature goes from an initial value through a maximum value and a minimum value and then returns to the initial value.

4.16 Time/Cycle-Significant Items

Time/cycle-significant items are functional hardware items which have a failure mode or probable failure mode which results from time/cycle operation or for which operating time/cycle data is required to justify and assure replacement or refurbishment because of limited life;
e.g.: Performance degradation due to wear-out characteristics of a sealing surface.

5.0 PROCEDURE

5.1 Reliability Data Center

5.1.1 The data center will consist of a failure reporting, analysis and corrective action section, a test histories section, a development and qualification history section, and a configuration histories section.

5.1.2 Data collected will be stored and processed using manual, semi-automatic and computerized handling methods.

5.1.3 Data will be retrievable by a number of ways such as part number, serial number, test type, test location, date of test, trend characteristics, assembly failure modes and component configuration.

5.1.4 All program disciplines will forward reliability information to the reliability data center as delineated in the responsibility of this procedure. For data sources see Figure 1, of Appendix I.

5.2 Data Input

The following data for NERVA engines, components, parts and materials will be stored and/or processed by the data center:

5.2.1 Test histories and results

5.2.2 Industrial failure data on NERVA items or items similar to those in the NERVA Program.

5.2.3 Configuration history

5.2.4 Qualification status and history

5.2.5 Interim and Final Problem - Failure Analysis Reports (FR, FAR)

5.2.6 Quality - Reliability Disposition Reports concerning reliability (QRDR)

5.2.7 Nonconforming Material Disposition Requests concerning reliability

5.2.8 Summaries of Failure Mode Analysis results, the criticality and effect on the engine system and status of corrective work

5.2.9 Performance Analysis Laboratory report data

5.2.10 Reliability apportionment, prediction and assessment data

5.2.11 Failure mode analyses (FMA)

5.2.12 Failure mode effects and criticality analyses corrective work (FMECA)

5.2.13 Reliability studies and reports

5.2.14 Trend data characteristics (TC's)

5.2.15 References to data in the quality assurance data collection system pertinent to reliability

5.2.16 Reliability data book (PRINCE/APIC)

5.2.17 End Item Reports concerning reliability (CEI)

5.2.18 Material review board and engineering review board data concerning reliability (MRB/ERB)

5.2.19 Interservice data exchange program data concerning reliability (IDEP)

5.2.20 Applicable AVCO and FARADA generic failure rate data

5.2.21 Flight readiness review reports

5.2.22 Fault tree analysis results and status of corrective work

5.2.23 Single point hazards analysis and status of corrective work

5.3 Data Output

The input data discussed in Section 4.2 shall be available. In addition, the following data shall be available through data processing:

5.3.1 Failure analysis and corrective action status lists

5.3.2 Checks for and a listing of unqualified parts in an engine.

5.3.3 Special reports to support problem area analyses, flight certifications, design changes, etc.

5.3.4 Analysis of trend data characteristics

5.3.5 Checks for and lists of unresolved failure modes

5.3.6 Reliability Failure Summary Reports

5.4 Test Results

5.4.1 The REDCRS shall be provided with hard or carbon copies of all test results to be reviewed for performance characteristics for incorporation into the reliability statistical data bank. These test and/or analysis results would include copies of engineering supplemental data sheets, acceptance data sheets, valve travel response times, material reports, trend data plots, metallurgical analysis reports, etc. Applicable forms shall be forwarded within one working day upon completion of the data reduction or the report to assure utilization of the data in the assessment of component failure/malfunction reports and to provide parameters for the Trend Data Characteristics analysis.

5.4.2 Upon review of test results the REDCRS shall initiate Special Data Requirements; Form AGC 4-331-3, A Test Request Supplement, Form AGCS 1900-7; or an Inspection/Test Referral, Form AGCS 0723-8; or facsimiles thereof as may be deemed necessary by Reliability Engineering to support trend data characteristics analyses and/or Reliability assessments and predictions. These data requests will be initiated when normal requirements are insufficient to provide the capabilities as outlined in the NERVA Trend Data Implementation Plan, Report 7850-0742, Section II, and the NERVA Reliability Allocations, Assessments, And Analysis Report, Data Item R-202, Section V.

5.4.3 Time/cycle information shall be part of the normal data reduction requirements and forwarded to REDCRS upon completion for incorporation into the component test configuration and trend data characteristics histories section. Forms shall be reasonable facsimiles of the formats included in Appendix I, Figures 2 and 3. This information will be accumulated to assist in the measurement of trend data characteristics as defined in the Identification And Control Of Trend Characteristics, Procedure R101-NRP-506, Paragraph 4.0.

[redacted] [redacted] [redacted]

5.4.4 A manual daily test log will be maintained to provide a chronological test program record by series and run numbers of engine and/or component testing in a format comparable to Figure 4 of Appendix I. This daily run log will serve as a quick reference document of test experience and associated failure reports for retrieval capabilities.

5.4.5 Daily component Reliability Performance Data Sheets in the formats comparable to Figures 5 to 7 of Appendix I for each serialized unit listed in Table I of Appendix I, or as determined upon completion of Engine PDR, will be maintained. These sheets will provide a continuous test, configuration, build and failure/malfunction history for each end item and time/cycle sensitive component. This information would be incorporated into the computerized REDCRS data bank within one working week in support of trend data characteristics and Reliability assessments (e.g. Figure 8, App I).

5.4.6 The above Reliability test data requirements will apply to and include hardware tested at all vendors, WANL, ANSC and site facilities such as ETS-1 and ES/TS-2. Similar data will be obtained from the customer when feasible or as mutually agreed upon.

5.5 End Item Documentation

5.5.1 The REDCRS staff will review the documentation of Completed Item Reports of deliverable hardware against the NERVA Reliability Performance Data Sheets to assure completeness and adequacy of the documentation with respect to configuration and discrepancy close-out.

5.5.2 REDCRS will provide an Operating Time Summary comparable to Figure 9 of Appendix I for each completed item report. This summary will utilize the Performance Data Sheets to document Time/cycle experienced on all components starting with vendor acceptance and running through completion of all formal testing.

5.5.3 A Failure Summary will be submitted by REDCRS for each Completed Item Report log book. Only basic data elements will be reported for each failed item in a format comparable to Figure 10 of Appendix I. This summary will be obtained from the Performance Data Sheets and verified against the Reliability Failure Listing, (e.g. Figure 11, App. I).

5.5.4 The REDCRS will provide a separate Replaced Components Failure Summary for each Completed Item Report in a format similar to Figure 12 of Appendix I, or facsimile thereof. This information will be obtained from the Performance Data Sheets and verified against the Quality Assurance Component Replacement Records of the Completed Item Report log book.

5.6 Reliability Failure Summary

5.6.1 The REDCRS shall develop and maintain a report of all failures, together with the status of failure investigation for transmittal to the government in Data Item R-105 in a format as outlined in Appendix II of this document and AFSCM/AFLCM 310-1 R-105, Failure Summary Reports.

5.6.2 The summary report will be an automated information system utilizing four basic input documents. The documents are the Performance Data Sheet, Failure Report or Departure/Non-Conformance Report, Failure Analysis Report which may include the closure or Corrective Action Report.

5.6.3 The Performance Data Sheet records will primarily be used in computing component failure rates and in compiling summarization of cumulative operating time/cycle information to be included in the Failure Analysis Report.

5.6.4 The Failure Report is utilized in a generic sense because all vendors will have their in-place failure reporting system with subsequent ANSC Failure Report number assignment. The basic data elements itemized for reporting failures should include and approximate a description as reflected in Figure 1 of Appendix II.

5.6.5 The Failure Analysis Report documents the results of the failure investigation and the recommendations of the Failure Resolution Board. The Failure Analysis Report may include the corrective action taken to resolve failure causes and prevent failure recurrence. Figure 2 of Appendix II or facsimile constitutes a Failure Analysis Report format.

5.6.6 REDCRS will provide Reliability Engineering for transmittal to the government a copy of each Failure Report within 24 hours of its receipt by the Data Center. This will be preceded by a Reliability Audit of Engineering Review Board decisions in the classifications of departures in which the REDCRS will serve as the liaison activity to provide additional data from the Quality Assurance Discrepancy Failure Information & Control Center, Configuration Control, Engineering and Test Operations with supporting evidence of industrial data, laboratory reports, trend data characteristics, etc.

5.6.7 Initiation of time/cycle records shall commence when components are operated as a part at vendor manufacturing assembly areas or when in test fixtures as subassemblies at all operating conditions including manufacturing control checkout, acceptance, qualification, off-limit, environmental or flight testing. For example: The Engine Performance Data Sheet will provide a cumulative count for each engine start from the initial thrust cycle. Actuator time data is recorded with the first application of electrical power to an actuation system at the vendor and eventually abstracted onto the Component Performance Data Sheet for the corresponding serial number.

5.6.8 Control of time/cycle shall be as determined and monitored by REDCRS. The operating time/cycle for any portion of an assembly accumulated by each time/cycle significant item contained within an end item is not to exceed established limits at acceptance by ANSC nor to exceed comparable limits at time of delivery to AEC-NASA. For example: An accumulated operating time of an actuator motor, under load, of twenty hours prior to delivery would require removal of the motor from the assembly, if the twenty hours constituted an operating limit prior to delivery. This monitoring will be accomplished through the Performance Data Sheet logs of the Reliability Data Center.

5.6.9 The recording of operating time/cycles shall be continued for the life of each component including after installation into the next higher assembly, until end of useful life. The records such as the Performance Data Sheets will indicate removed and replaced items with their respective operating time/cycles. For example: The records of an actuator assembly containing a motor which has previously been operated in another actuator assembly will include within the total all previous operating time of the motor. This information will provide the data necessary to support the requirements as described in the Analysis and Verification Of Trend Characteristics, Procedure R101-NRP-508, Paragraph 7.1.4 and provide the capability for the policy established in the Development And Implementation of Trend Characteristic Monitoring Systems, Procedure R101-NRP-507, Paragraph 3.5.

5.6.10 The operating time/cycles will be accumulated respectively for each component and become the time/cycle of the most operated sub-component included in the assembly. Replacement or complete refurbishment of all wear-sensitive parts allows reversion to Zero time/cycle. For example: Replacement of a poppet within a valve without refurbishment of the seat, constitutes continuation of cycle accumulation for that valve. REDCRS shall provide this data capability by maintaining accurate Performance Data Sheets through the data flow to the Reliability Data Center.

5.6.11 The REDCRS shall maintain an index of newly defined Reliability terms as a supplement to the Glossary of Reliability Terms, Procedure R101-NRP-307 and use these terms as defined.

5.6.12 REDCRS shall provide and make aware the Flight Safety Analysis Section of any engineering changes and observed discrepancies that could potentially affect the single-failure-point analysis as outlined in the Single-Failure-Point Reporting, Analysis, Correction & Closeout, Procedure R101-NRP-306.

6.0 APPLICABILITY

6.1 System Effectiveness

6.1.1 The REDCRS will be formed at Engine PDR and integrate concurrently with all program disciplines in implementing required procedures to place the REDCRS into effective operation.

6.1.2 The details of the REDCRS procedures shall be fully implemented at Component DDR to parallel the program efforts in establishing Reliability Goals.

7.0 RESPONSIBILITY

7.1 Reliability Data Collection and Reporting System (REDCRS)

7.1.1 The REDCRS staff will provide support and technical assistance to the personnel of the Reliability And Safety Analysis Section as directed by the Reliability Engineering Supervisor.

7.1.2 The REDCRS will be responsible for procuring and maintaining all data input and output of Paragraphs 5.2 and 5.3. Prime responsibility shall be with REDCRS for obtaining Data Item 3, as reflected in Figure 1 of Appendix I and provide the necessary liaison activity to assure the flow of data from the remainder of data sources.

7.1.3 REDCRS shall be responsible for formating the Reliability Performance Data Sheets in such a manner that it can be forwarded for key punch input to provide machine processing, sort, and statistical analysis of all accumulated data.

7.1.4 The REDCRS technical staff shall review with the cognizant project engineers the inclusion of the critical performance parameters on the Performance Data Sheets for each component as outlined in Paragraph 5.4.5.

7.1.5 The REDCRS staff will be responsible for obtaining all manufacturing, test and configuration data on a daily basis for entry into the appropriate manual Performance Data Sheet logs and summarize the data for inclusion in the component data reports. The responsibility will be extended to include all vendors and the customer.

7.1.6 Upon request, the REDCRS shall be responsible for procuring all test records that may be required from Central Data Control of the nature as described in the ANSC supplement to the NERVA Data and Document Control Plan, Data Item C100 dated March 1970, Paragraph 2.7.1 and any additional data as may be determined upon review of Data Item T-119, Test Reports.

7.1.7 The REDCRS shall be responsible to the extent as determined by Reliability Engineering in the collection, analysis and summarization of Trend Data Characteristics.

7.1.8 The reliability documentation input shall be the responsibility of the REDCRS for all completed item reports in accordance with the NERVA Configuration Management Plan (Supplement) dated September 1969, Data Item C-013, Paragraph 3.0 and 6.4 for submittal to Quality Assurance Data & Document Center Completed Item Report log book.

7.1.9 The REDCRS staff shall notify the government within 24 hours of all departures classified by ERB as failures and record the Failure Report with pertinent information in the Reliability

Summary Report in a format comparable with the Failure Summary Reports, AFSCM/AFLCM 310-1 R-105 and provide closeout status summaries to provide the follow-up capability for the Failure Analysis And Corrective Action Procedure R101-NRP-504.

7.1.10 The REDCRS staff will advise Reliability Engineering of any recurring problem areas of reported departures within 8 hours of observance and provide a summary printout as required. It will be the responsibility of the REDCRS to provide Quality Assurance with summaries of observed problem areas to assist in the quality analysis as described in the Quality Assurance Program Plan, Data Item P-017, Paragraph 4.1.1.

7.1.11 The REDCRS staff will have the responsibility to support the secretary of the Failure Review Board in the adequate implementation of the Failure Control System through the diversification of the Reliability Data Center and processing copies of all documents and reports transmitted to the Failure Review Board as depicted in Figure 1 of Data Item M-001, Failure Control System.

7.1.12 REDCRS will be responsible to maintain the capability within the Reliability Data Center to provide the necessary documentation to allow compliance with the Subcontractor and Vendor Reliability Plans, Procedure R101-NRP-701, Paragraph 4.2.4.

7.1.13 It will be the responsibility of the REDCRS to provide monitoring capabilities for the Contract and Procurement Specification Reliability Requirements, Procedure R101-NRP-700, Paragraph 4.1 in the form of Manual Performance Data Sheet logs.

7.1.14 REDCRS will be responsible for maintaining the Interagency Data Exchange Program to supply Reliability Engineering with the monitoring capability for the Parts and Material Data Selection and Control System, Procedure R101-NRP-704, Paragraph 5.5.1 and procure from Receiving Inspection copies of the information as delineated in Paragraph 5.11 of the NRP-704.

7.1.15 The REDCRS staff shall be responsible for implementing the effectivity of the Reliability Data Center and this procedure. In this position the REDCRS staff will report directly to the Reliability Engineering Supervisor and make recommendations regarding improvement in data collection and failure reporting systems.

7.2 Quality Assurance

7.2.1 The Quality Assurance Discrepancy/Failure Information & Control Center as a satellite subsystem of the Quality Assurance Data & Documentation Center shall make available tissue copies of all departure reports of anamolies presenting a potential program impact within 8 hours after the departure event. REDCRS personnel will accumulate these tissues on a daily basis for monitoring purposes by Reliability Engineering.

7.2.2 Quality Assurance Data & Documentation Center will make available to Reliability Engineering all top vellum copies of Departure Reports for pick-up by the REDCRS staff upon completion of Quality Assurance data processing. This will serve as a final monitor of any potential problems due to oversight and identification of recurring discrepancies to assure product effectiveness as related in the NERVA Product Assurance Program Plan, Data Item P-017, Paragraph 1.4 and Section 4.

7.2.3 It will be the responsibility of the Quality Assurance Data & Documentation Center to provide a Discrepancy Listing printout on a quarterly basis and a comprehensive report on an annual basis. A comparable report shall be forwarded to REDCRS of vendor departures.

7.2.4 Quality Assurance shall be responsible for securing the recording of all time/cycle information by Inspection personnel and making available within 8 hours all completed time/cycle sheets, or upon the initiation of a Departure Report for that component which is accumulating time/cycle. The applicable Departure Report number shall be recorded on the time/cycle record for abstraction onto the Reliability Performance Data Sheets. The REDCRS staff will accumulate the time/cycle records on a daily basis from Quality Assurance collection points.

7.2.5 The Quality Assurance Data & Documentation Center shall make available the remainder of documents not specifically discussed as reflected in Data Items △1 and △2 of Figure 1, Appendix I. The REDCRS will accumulate these documents on a daily basis for incorporation of data abstracts into the appropriate reliability data logs for summary documentation input and monitoring purposes.

7.2.6 The Quality Assurance Data & Documentation Center shall provide the REDCRS with all reports and documents as depicted in Figure 1 of Data Item M-001, Failure Control System to provide the processing function for the secretary of the Failure Resolution Board.

7.3 <u>Engineering</u>

7.3.1 It is the responsibility of Engineering that Reliability Engineering is provided all design and test information through REDCRS channels. The REDCRS shall be provided or made aware of test and analysis results from all sources as depicted by Data Item △6 of Figure 1, Appendix I.

7.3.2 Engineering shall notify REDCRS of any and all anomalies observed during testing, manufacturing and assembling of hardware not normally covered by inspection procedures.

7.3.3 The REDCRS shall be provided with copies of test plans/requests and status reports for reliability test plan review and data assimilation. REDCRS shall be forwarded copies or made aware of all engineering analysis reports generated by ANSC Engineering Sections. The acquisition of these documents will make the provisions for the compliance to the Reliability Review of Test Plans, Procedure R101-NRP-501, Paragraph 5.0 and furnish a check on the framework within which the NERVA Reliability model can be tested as outlined in the Reliability Test and Evaluation Plan, Data Item R-106.

7.4 Test Operations

7.4.1 Test and site operations will forward to REDCRS copies of all documents as depicted in Data Item 5 of Figure 1, Appendix I or data integration and collection purposes.

7.4.2 Test Operations shall process all Reliability data requirements as outlined in Paragraphs 5.4.2 and 5.4.3 in support of Reliability Engineering.

7.5 Laboratories

7.5.1 REDCRS shall be on distribution for all test request supplements and all analysis/test reports generated by the responsible Engineering Laboratory.

7.5.2 All laboratories will provide any data analyses necessary for adequate reliability design evaluation as requested in a manner outlined in Paragraph 5.4.2 from all sources as reflected in Item 6 of Figure 1, Appendix I.

7.6 Configuration

7.6.1 Configuration Control shall make available, in copy form or in the form of a new Issues List, all documents as portrayed in Item 4 of Figure 1, Appendix I for proper reliability design evaluation. The applicable documents shall be forwarded to REDCRS.

7.7 Central Data Control

7.7.1 It shall be the responsibility of Central Data Control to provide upon request any test records for review by REDCRS personnel of the type as outlined in Data Item C-100, Supplement To NERVA Data and Documentation Control Plan, dated March 1970, Paragraph 2.7.1.

7.8 Computer Services

7.8.1 Computer Services shall be responsible for providing programming and computer service as requested by REDCRS in support of the Reliability Data Center.

7.9 Manufacturing Engineering

7.9.1 The responsibility for providing copies of NERVA Program Requisitions to REDCRS shall be with Manufacturing Engineering.

7.10 Mission Systems Requirements Section

7.10.1 The Mission Systems Requirements Section shall have the responsibility of providing Reliability Engineering any new or additional requirements affecting Reliability predictions by forwarding them to REDCRS.

APPENDIX I

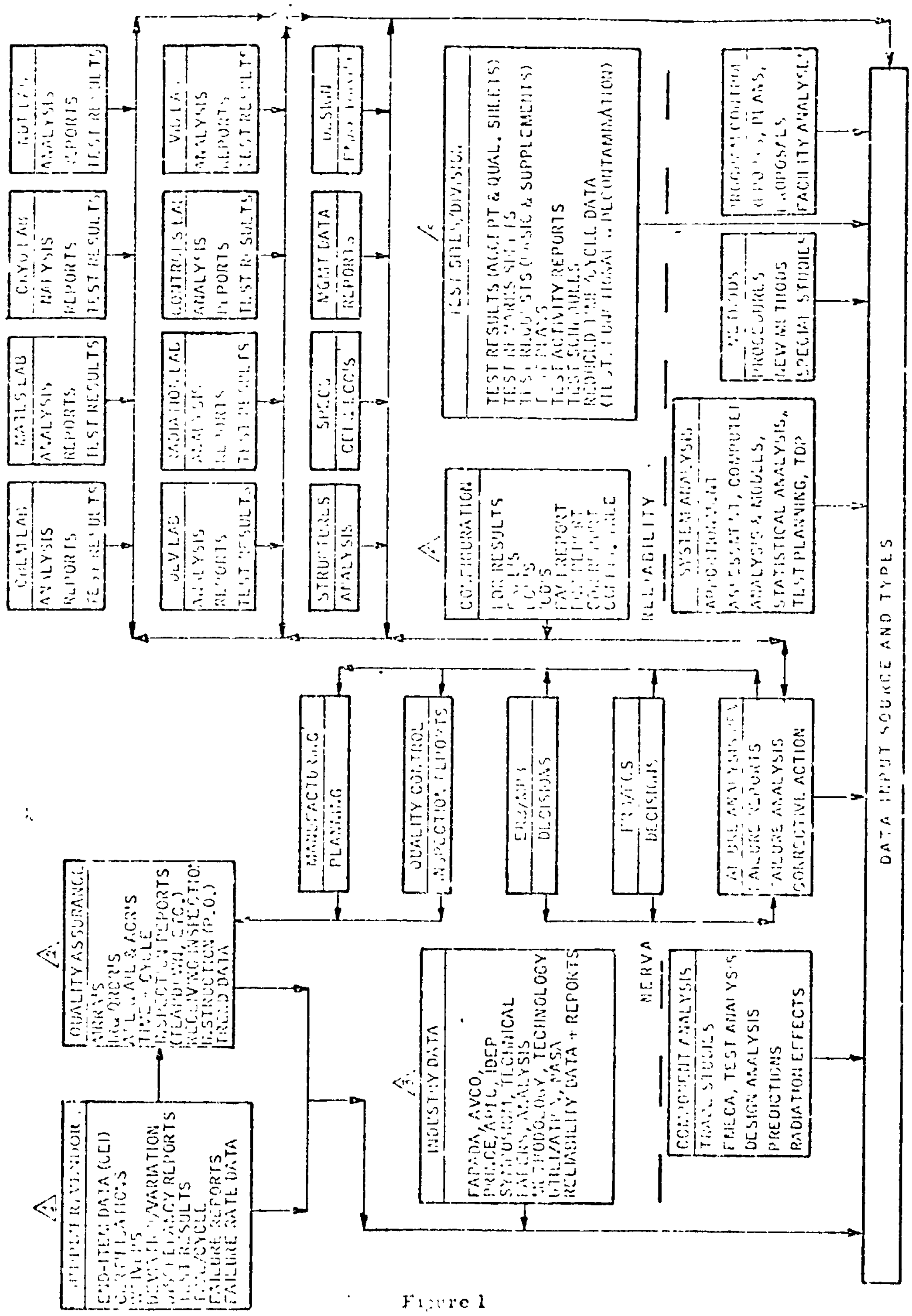

Figure 1

APPENDIX I

RELIABILITY PERFORMANCE DATA SHEETS

LIST OF SERIALIZED UNITS

1. NERVA ENGINE
2. UPPER THRUST STRUCTURE
3. LOWER THRUST STPUCTURE
4. EXTERNAL SHIELD SUBSYSTEM
5. PRESSURE VESSEL & CLOSURE
6. GIMBAL ASSEMBLY SUBSYSTEM
7. GIMBAL ACTUATOR
8. STRUCTURAL SUPPORT COOLANT VALVE
9. STRUCTURAL SUPPORT COOLANT VALVE ACTUATOR
10. TURBOPUMP ASSEMBLY
11. PROPELLANT SHUTOFF VALVE & ACTUATOR
12. BYPASS CONTROL VALVE & ACTUATOR
13. BYPASS BLOCK VALVE & ACTUATOR
14. TURBINE BLOCK VALVE & ACTUATOR
15. PUMP DISCHARGE CHECK VALVES
16. COOLDOWN SUPPLY CONTROL VALVE & ACTUATOR
17. COOLDOWN SHUTOFF CONTROL VALVE & ACTUATOR
18. TURBINE DISCHARGE BLOCK VALVE & ACTUATOR
19. STRUCTURAL SUPPORT BLOCK VALVE & ACTUATOR
20. TURBINE THROTTLE VALVE & ACTUATOR
21. STAGE TANK PRESSURIZATION LINE & CHECK VALVE
22. ENGINE PURGE UNIT
23. PROPELLANT LINES
24. NOZZLE
25. NOZZLE EXTENSION

LIST OF PARAMETERS

1. Time/Cycle
2. Test Location
3. Test Type
4. Test Date
5. Test Number
6. Test Failure Information
7. Test Failure Number
8. Test Parameters
9. Test Media
10. Coast Time
11. Serial Number
12. Part Number
13. Serial Numbers of Associated Components
14. Configuration Information
15. Anomoly Information
16. Test Remarks

Table 1

APPENDIX I

ACTUATOR MOTOR OPERATING RECORD

NERVA TIME AND CYCLE DATA

Engineer ______________ Actuator ______________

Technician ______________ P N ______________

Date ______________ S N ______________

Channel ______________

TEST \ CONDITION	TOTAL MOTOR RUNNING TIME, (min)	CONTROL CURRENT MOTOR RUNNING TIME, (sec)	CYCLES
Snubber Test			
Ramp Response Test			
Static Load Test			
Miscellaneous Test			

Return to NERVA Reliability

Figure 2

APPENDIX I

ACTUATION
TIME/CYCLE DATA

Page _____ of _____

Actuation Assembly Part No. ____________________

Serial No. ____________________

Shop Order No. ______________ or Test Series No. ____________________

Sequence or Test Run Number	Time, Sec.	Cycles	Inert Gas Pressurization Proof Pressure Cycles

Date: ____________________

Inspector: ____________________

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Ref:

Figure 3

APPENDIX I

TIME AND CYCLE RECORD PAGE ___ OF ___

DATE	ENGINE ASSY. PN ______ SN ______	VALVE ASSY. PN ______ SN ______
ACTUATION ASSY. PN ______ SN ______		I. R. NO.

TEST RUN NO.	TEST TYPE	DRY, WET OR DECONTAM.	VALVE MODE	TIME, SEC	CYCLES	PRESSURE	
	PRE						
	RUN						
	POST						
	PRE						
	RUN						
	POST						
	PRE						
	RUN						
	POST						
	PRE						
	RUN						
	POST						

DATA REDUCTION: ______

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Figure 3A

APPENDIX I

TEST NUMBER	DATE	T int.	T act.		ENG. S/N	FAR NO.	TEST STAND
1 3	19	32	38	44	47	59	CARD COLUMN

Figure 4

APPENDIX I

NOZZLE EXTENSION RELIABILITY TEST DATA

NOZZLE SN	NOZZLE PN	VENDOR SN
0000054	1118941-3	

BLOCK II

CYCLE	DATE MO DY YR	TEST NUMBER	DURATION	ENG	P C DELTA	REMARKS
244	060868	2M1731M018	1.0	055E	123	
245		19	1.9		124	TOTALS 3291.3 Test Failure - Flange Leakage
246		N001	1.0		116	
247		2	1.0		117	
248		3	1.0		117	
249		4	1.0		118	
250		5	1.0		118	
251		6	1.0		118	
252		7	1.0		123	
253		8	1.0		123	
254		9	4.6		121	TOTALS 3303.9 Test Failure - Flange Leakage
255	062768	P001	1.0		102	
256		2	1.0		102	
257		3	1.0		103	
258		4	1.0		102	
259		5	1.0		103	
260		6	1.0		100	
261		7	1.0		102	
262		8	1.0		101	
263	062868	9	1.0		101	
264		10	1.0		102	
265		11	1.0		102	
266		12	1.0		102	
267		13	1.0		102	
268		14	1.0		119	
269		15	1.0		120	
270		16	1.0		120	

PLEASE PRINT CLEARLY — USE BLACK PENCIL

Figure 5

APPENDIX I

ENGINE RELIABILITY TEST DATA

ENGINE SN	ENGINE PN	[illegible] SN	[illegible] SN	VALVE SN	ACTUATOR SN (P)	ACTUATOR SN (Y)	NOZZLE SN

CYCLE	DATE MO DY YR	TEST NUMBER	DURATION	COAST TIME (MIN)	AMT OR CAL	[illegible]	PROP. TEMP. °F	Pc PSIA				GIMBAL CYCLES PITCH	GIMBAL CYCLES YAW	T/C	REMARKS

PLEASE PRINT CLEARLY — USE BLACK PENCIL

Figure 6

APPENDIX I

RELIABILITY TEST DATA

	VALVE [illegible]	VALVE [illegible]	[illegible]	

CYCLE	DATE MO DY YR	TEST NUMBER	DURATION	ENG. [illegible]	TEST M DIA	Open/Travel Time Travel	Open/Travel Time Total	Open/Travel Time Travel	Open/Travel Time Total	Closing/Travel Time Travel	Closing/Travel Time Total	Closing/Travel Time Travel	Closing/Travel Time Total			CYCLE	[illegible]

Figure 7

APPENDIX I

[illegible]

Figure 8

APPENDIX I

PART NAME ______
PART NUMBER ______
SERIAL NUMBER ______

OPERATING TIME SUMMARY

DATE ______
TOP ASSEMBLY ______
SERIAL NUMBER ______

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	TYPE OF [illegible]	REMARKS

SECTION ______ PAGE ______

Figure [illegible]

APPENDIX I

PART NAME ______ PART NUMBER ______ SERIAL NUMBER ______ DATE ______	FAILURE AND MALFUNCTION SUMMARY TOP ASSY. ______ SERIAL NO. ______	MC ______ ME ______ AGC SPEC. ______ CONTRACT NO. ______

FR NUMBER	PART NUMBER	SERIAL NUMBER	PART NAME	TYPE OF FAILURE	DATE	LOCATION WHERE OCCURRED

SECTION ______ PAGE ______

Figure 10

APPENDIX I

Component Serial Number	Component Part Number	Top Assembly Serial Number	Failure Mode Code	Failure Date	Failure Report (FR) Number	Customer Notification Date	FR Transmittal Date	Failure Analysis Report (FAR) Number	FAR Transmittal Date	FAR Status Code	Discrepancy Report Number (IR)	Location of Failure Occurrence	Number of Discrepancy	Type of Test Code

Figure II

APPENDIX I

PART NAME ______ PART NUMBER ______ SERIAL NUMBER ______ DATE ______	REPLACED COMPONENTS FAILURE AND MALFUNCTION SUMMARY TOP ASSY. ______ SERIAL NO. ______	MC ______ ME ______ AGC SPEC. ______ CONTRACT NO. ______

FR NUMBER	PART NUMBER	SERIAL NUMBER	PART NAME	TYPE OF FAILURE	DATE	LOCATION WHERE OCCURRED

SECTION ______ PAGE ______

Figure 12

APPENDIX II

1.0 INTRODUCTION

A computerized data file provides a uniform and regulated system of information, transmission, and follow-up and provides for analysis and corrective action regarding failures.

The purpose of the data file is to record deficiencies in design, manufacturing, test and check-out when reported via failure reports. It is coded to provide the failure data on NERVA components, to aid in the determination of failure rates and to help monitor failure analysis and corrective action for product improvement. Test failures that are considered assessable against the reliability requirements of the part will be so noted.

The failure analysis and corrective action section of the data file is to document failure analysis action, the basic cause of a failure, and the resulting recommended corrective action. It also documents the corrective action taken to close the failure-to-fix loop, thus increasing reliability by product improvement.

The initial data inputs for the program are obtained from failure reports. This data, as well as data not contained on the failure reports, but equally as important, is input to the computer file via key-punch cards. The data on each failure is transcribed onto the Keypunch Transmittal by clerical and engineering personnel.

While the program uses some coded inputs (these inputs may be altered to provide a system of standardization), all output reports are converted to plain language. The computer program used provides for sorted output based on any of the coded inputs.

Once data has been input to the data file, reports can be generated immediately. It is required, however, that users of the output reports notify REDCRS at least two days in advance when such output reports are required.

To make this data file useful, it will be necessary for the REDCRS to receive feedback from all potential and existing users. With this feedback, problem areas will be resolved and the Reliability Data Banks will be a useful tool to all of NERVA.

2.0 RELIABILITY FAILURE SUMMARY PROGRAM

Figure 3 shows the Reliability Data Collection Transmittal Form that will be used to convert the data on Failure Reports to the data acceptable by the computer. Most of the data required on this transmittal is in plain language. The codes that may be used are explained in Section 3.0.

APPENDIX II

Each field of Figure 3 has a number in brackets. This number refers to the detailed explanation.

The following list describes the minimum amount of data that is required to initiate a record in the data bank. The items listed here are transcribed from the Failure Report to the Reliability Failure Summary Program by REDCRS personnel. The remainder of the items on the Transmittal are completed by the responsible Reliability Engineer.

ITEM*	
1	Failure Report Number
4	Date Failure Occurred
6 6a 6b 6c 6e	Failed Item Name, Part Number and Serial Number
7 7a 7b 7c 7e	**Next Assembly Name, Part Number and Serial Number
18	Manufacturer of Failed Item
23	Test phase/Operation code
29	Project Code
30	Subsystem Code

2.1 DETAIL EXPLANATION: RELIABILITY FAILURE SUMMARY PROGRAM

Item	Card	Columns	
(1)	1-9 & A-I	2-6	Failure Report Number (5 digits). This need only be entered at the top left hand corner of the transmittal.
(1a)	1-9 & A-I		Failure assessability code

* Item refers to item numbers in the detailed explanation (Section 2.1)

** If the failed item is easily associated with a subsystem, repeat items 6a thru 6e in items 7a thru 7e

APPENDIX II

Item	Card	Columns	
(2)	1-9 & A-I	8	Change Code (Leave Blank for addition of data; enter the letter "C" if data in the field is to be changed; enter the letter "D" if deletion of any field is required).
(3)	1	9	Status (Leave blank if failure is in process; enter the letter "C" if failure is considered closed; enter the letter "H" if the failure was closed the preceding month and transfer to historical file is requested).
(4)	1	10-17	Date Failure Occurred (Month-day-year sequence).
(5)	1	18-21	Cumulative Operating Time of Failed Item (Hours only).
(6)	1	22-38	Failed Item Name
(6a)	2	.22-23	*Prefix of failed item part number, if a prefix exists (alphabetic).
(6b)	2	24-29	Part Number (6 digit)
(6c)	2	31-32	*Configuration Dash Number (2 digit)
(6d)	2	33-34	*Engineering Order Revision Letter and number that item was built to.
(6e)	2	36-39	Serial Number of Failed Item (4 digit)
(7)	1	41-57	Next Assembly Name (Refers to the next higher assembly of the failed item)
(7a)	2	40-41	*Prefix of next assembly part number (alphabetic)
(7b)	2	42-47	Part Number (6 digit)

* If this information is not available leave these fields blank.

APPENDIX II

Item	Card	Columns	
(7c)	2	49-50	*Configuration Dash Number (2 digit)
(7d)	2	51-52	*Engineering Order Revision Letter and number that assembly was built to (i.e., EO A1, A2, ...A5, B1, B2, ...B5, etc.)
(7e)	2	54-57	Serial Number of next higher assembly (4 digit)
(8)	1	58-75	Highest assembly name (name of an assembly associated with the failed item that can easily be associated with a subsystem).
(8a)	2	58-59	*Prefix of Highest Assembly Part Number.
(8b)	2	60-65	Part Number (6 digit)
(8c)	2	67-68	*Configuration Dash Number (2 digit)
(8d)	2	69-70	*Engineering Order Revision Letter and Number that assembly was built to.
(8e)	2	72-75	*Serial Number of Highest Assembly or Spacecraft Serial Number failed item was intended for.
(9)	1	76-80	*Non-conforming Materials Report Number (5 digit)
(10)	2	9-21	Responsible Engineer's Name
(11)	2	76-80	Discrepancy Departure Report Number (5 digit)
(12)	3	9-11	Mode of Failure Code
(13)	3	12-70	Description of Failure (Alphanumeric Description of Failure).

* If this information is not available leave these fields blank

APPENDIX II

Item	Card	Columns	
(14)	3	71-73	Time in hours required for diagnosis.
(15)	3	74-76	*Time in hours required for repair.
(16)	3	77-79	*Time in hours required for checkout after repairs.
(17)	4	10-14	Reference Failure Report Number (5 digit).
(18)	4	15-19	Manufacturer of Failed Item. Code: This is the 5 digit number given to each manufacturer in the government handbook H-4.
(19)	4	20-37	Number of test procedure and paragraph that was being used when item failed.
(20)	4	38-39	Failed Item Code
(21)	4	40-41	Disposition of Failed Item Code
(22)	4	42-43	Cause of failure code
(23)	4	44-45	Test Phase/Operation Code
(24)	4	46-48	If the cause of failure item (22) is a part deficiency enter the part type here otherwise leave this field blank.
(25)	4	49-51	Part mode of failure code
(26)	4	52-56	*The reference designation or symbol of the failed part should be entered here.
(27)	4	57	Severity of Failure 1. Critical 2. Major 3. Minor
(28)	4	58-70	*Originator's name and/or badge number

* If this information is not available leave these fields blank.

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Item	Card	Columns	
(29)	4	71-75	Project Code (NERVA)
(30)	4	76-80	Subsystem Code
(31)**	5	19-36	Part specification of failed part
(32)**	5	42-46	Manufacturer of failed part. (Code: This is the 5 digit number given to each manufacturer by government handbook H-4)
(33)**	5	63-80	*Reference Report Number. If failure was due to a part deficiency there should be a report from parts application as to the mode and cause of failure.
(34)	5*	9-80	Cause of Failure. If the cause of failure code item (22), is not a part deficiency then disregard items (31), (32) and (33). Use this card to fully describe the cause of failure code (item 22).
(35)	6	26-80	Failure Analysis
(36)	7	9-77	Continued Failure Analysis
(37)	8	27-78	Corrective Action
(38)	8	79-80	Correction Action Results Code (See code appendix)
(39)	9	9-77	Continued Corrective Action
(40)	A	9-80	Corrective Action/Comments
(48)	I	9-80	Corrective Action/Comments

* If this information is not available leave these fields blank.

** Items (31), (32) and (33) make up a complete card 5. If they are not used (item 22 is not a part deficiency) then item (34) should be completed. Note that if items (31), (32) (33) and (34) are completed, two cards exist.

APPENDIX II

3.0 CODE SECTION

1. Project Code
2. Mode of Failure Code
   (a) Alphabetic Listing
   (b) Numeric Listing
3. Failed Item Code
4. Failure Mechanism Code
5. Cause of Failure Code
6. Test Operation/Phase Code
7. Part Type Code
8. Subsystem Code
9. Corrective Action Code

3.1 Project Code

Four letter abbrevation of the project name (optional), such as:

NERV	-	NERVA
APOL	-	APOLLO
TITA	-	TITAN
GEMI	-	GEMINI

3.2(a) Mode of Failure - Alphabetical Listing

034	External Leakage
005	Fails to Close (Emergency Close Speed)
004	Fails to Close (Normal Speed)
003	Fails to Open
002	Inadvertent Closure
001	Inadvertent Open
	Etc.

3.2(b) Mode of Failure - Numeric Listing

001	Inadvertent Open
002	Inadvertent Closure
003	Fails to Open
004	Fails to Close (Normal Speed)
005	Fails to Close (Emergency Close Speed)
	Etc.

APPENDIX II

3.3 Failed Item Identification Code

Failed Item	Code
Adapter-Actuator	1
Adapter-Bearing	2
Adapter-Power Spring	3
Ball	4
Ball-Ball Screw Mech.	5
Ball-Lock	6
Bearing (Roll. El.)	7
Bearing-Sleeve	8
Bearing-Thrust	9
Bearing-Thrust Wash.	10
Bellows	11
Body	12
Bolt(s)	13
Bolt-Shouldered	14
Bushing	15
Cam	16
Cam Follower	17
Cam-Locking	18
Cam-Seal Lift	19
Cap-End	20
Carrier-Planet Gear	21
Clutch	22
Cone-Flow Guide	23
Connector-Electrical	24
Coupling	25
Cover-Plan. Gear Carrier	26
Cover-Potentiometer	27
Cover-Pressure	28
Cover-Seal	29
Flange	30
Frame-Seal Lift Assembly	31
Gasket (Crush)	32
Gate-(Flapper)	33
Gate (Rotary)	34
Gears	35
Gear-Fixed Ring	36
Gear-Output	37
Gear-Pinion	38
Gear-Planet	39
Gear-Sun	40
Etc.	

APPENDIX II

3.4 Failure Mechanism

Mechanism	Code
Bearing Stress	1
Bending Stress	2
Compression Stress	3
Environmental Stress	4
Fatigue Stress	5
Impact Stress	6
Shear Stress	7
Shear Stress, Galling	8
Tensile Stress	9
Thermal Deterioration	10
Etc.	

3.5 Cause of Failure Code

CAUSE OF FAILURE	Code
Mfg/Wiring error	01
Mfg/Assembly error	02
Mfg/Mishandled	03
Mfg/Workmanship	04
Mfg/Oper personnel	05
Mfg/Wrong part inst.	06
Mfg/Missing part	07
Mfg/Test equipment	08
Mfg/Shipping damage	09
*Part def/Prim fail.	20
*Part def/Sec failure	21
Part def/Out of spec	22
Part def/Deterior	23
Part def/End of life	24
Part Elect. Overstress	25
Part def/Vendor QC	26
Part def/Vendor spec	27
Under investigation	31
Customer/OpPersonnel	32

* Codes to be developed

APPENDIX II

Cause of Failure	Code
Customer/Test Equipment	33
Customer/Change Req.	34
Customer/Handling	35
Technical Order	38
Eng/Design Error	39
Eng/Part Application	40
Eng/Circuit Incompat	41
Eng/Spec Err/Change	42
Eng/Test PE/Change	43
Eng/Excess Tolerance	44
Eng/Insuf Tol/Safety	45
Eng/Test Equipment	46
Eng/Oper Personnel	47
Eng/Draw Error	48
Eng/Parts Layout	49
Env/Altitude	50
Env/Operational	51
Acceleration	53
Humidity	56
Pressure	59
Shock	65
Storage	68
Temperature	71
Etc.	

3.6 Test Operation/Phase Code

TYPE TEST OPER/PHASE	CODE
Op/Resistance	60
Op/Calibration	61
Op/Testing	62

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Type Test Oper/Phase	Code
Detail/Assembly Area	70
Acceptance/T/V	71
Bench Post Vib.	72
Vibration	73
High Temp	74
Low Temp	75
Shock	76
Post Temp/Alt	77
Production Test	78
Post Env. Bench	79
Vendor/Temp	80
Vendor/Vibration	81
Vendor/Final	82
Etc.	

3.7 Part Type Code

Part Type	Code
Res/Carbon Film	RCF
Res/Carbon Comp.	RCC
Res/ Metal Film	RMF
Res/WW Accurate	RWA
Res/WW Power	RWP
Res/WW Variable	RWV
Res/Carbon Comp/Var	RCV
Res/Thin Film/Ntwk	RTN
Res/Metal Oxide	RMO
Diode/Sil General	DGS
Diode/Sil Zener/Ref	DZE
Diode/Sil Switching	DSS
Diode/Sil Tunnel	DTU
Diode/Sil Varactor	DVA
Diode/Sil MicroMixer	DMM
Diode/Sil MicroDtctr	DMD
Etc.	

APPENDIX II

3.8 Subsystem and Type Failure Code*

VALVE -	Adverse Tolerance Stack up	VA001
	Ball Spline Raceway Too Shallow	VA002
	Bearing Installation Discrepancy	VA003
	Bearing Ring Raceway Too Shallow	VA004
	Bearing Seizure	VA005
	Bending (Due to Misalignment)	VA006
	Contact Angle Mismatched to direction of load	VA007
	Contamination	VA008
	Contamination, Conductance over surface of insulator	VA009
	Corrosion of Incompatible Materials	VA010
	Corrosive Atmosphere	VA011
	Cryogenic Brittleness	VA012
	Etc.	

3.9 Corrective Action Code

Redsign	001
Specification Change	002
Procedure Change	003
Retest	004
Accept As Is	005
Etc.	

* The subsystem code includes the type of contributory mechanism (3 digits)

APPENDIX II

4.0 RELIABILITY FAILURE SUMMARY REPORT DATA ITEM DESCRIPTION

4.1 Each report shall contain the information listed below pertaining to failures of NERVA items or any constituent elements thereof detected during actions conducted by or under the cognizance of the NERVA Program.

4.2 Listing of Key Data From Individual Failure Reports. A section of each summary report shall provide a columnar listing of principal data from each failure report generated during the report period. As a minimum, the data shall be as listed below and the format of its presentation in the report shall be as proposed by the NERVA Reliability and approved by the government.

	Definitions of Terms
Failure report number	No clarification required
Mission, design, series	This refers to the identification of the system, equipment, etc.
Serial No.	No clarification required
Accumulated time on system	Time in hours, cycles, days, etc., whichever is applicable.
Date of failure	No clarification required
Identification by subsystem and/or assembly	No clarification required
Subsystem/assembly serial number	No clarification required
Failed component by part number	This refers to the "black box" unit, the item that is normally removed from the vehicle for repair or on which maintenance is required.
Failed component serial number	No clarification required
Failed component manufacturer	No clarification required
Accumulated time on component (time on component at time of trouble, time in hours, minutes, cycles and/or calendar including number of starts if applicable)	Accumulated time should be spelled out in time, cycles, or calendar days, whichever is most applicable to the component.
Nomenclature of failed component if applicable	This refers to the part that was repaired or removed and replaced in the component.
Piece part manufacturer	No clarification required
Identification by circuit location	For the purpose of identifying the piece part in case several piece parts by the same name are utilized in the component.
Description and/or symptom of failure	Whether it was short, open, beyond allowable tolerances, etc., and the cause of failure if known. Stresses acting on the failed part, if known, should be included. This may have to be left open until failure analyses are completed. If left open, the agency investigating the cause and expected date of completion should be stated.

APPENDIX II

	Definitions of Terms
*Fault location time	The time required to identify the trouble; particularly applicable to testing since it applies to the component.
*Fault correction time	That element of maintenance time during which a failure is corrected by (a) repairing in place; (b) removing, repairing, and replacing; or (c) removing and replacing with a like serviceable item. This again applies to testing either on or off vehicle.
*Corrective maintenance time	The duration of time in which the effort is halted due to actions performed, as a result of failure, to restore an item to a specified condition.
*Reason for corrective maintenance time (if corrective maintenance time is much greater than the sum of fault location time and fault correction time)	No clarification required
Trouble severity	
Catastrophic	Any failure which could result in death or injuries or prevent performance of the intended mission.
Critical	Any failure which will degrade the system beyond acceptable limits and create a safety hazard (could cause death or injury if corrective action is not immediately taken
Major	Any failure which will degrade the system beyond acceptable limits but which can be adequately counteracted or controlled by alternate means.
Minor	Any failure which does not degrade the overall system performance beyond acceptable limits - one of the nuisance variety.
Categorization of failure (primary or secondary.	No clarification required.
Corrective action recommended to avoid repetion of trouble	No clarification required.
Dates of completion and final closeout of corrective action	This required two dates: (1) when the fix has been incorporated in the component subsystem or system and (2) when sufficient data are obtained to determine that the fix has corrected the trouble.
Number of occurrences of trouble itemized as to specific cause	The number of failures occurring on all components of this part number.
Total operating time	The total operating time that has been accumulated on all the components (of this part number) since manufacture or overhaul.
*Total number of units in use at time of trouble.	No clarification required.

* Optional

APPENDIX II

4.3 Tabulation of Cumulative Failure Statistics. A section of each summary report shall provide a tabulation of cumulative statistics pertaining to failures reported under the contract from its initiation through the data compilation cutoff date for that report period. The identification and statistical data tabulated and the format of its presentation shall be as proposed by REDCRS and approved by the government.

4.4 It is intendeded that the formation contained in these reports shall be sufficient to provide the government with the visibility required to recognize all significant reliability problems detectable through use of the NERVA failure data collection and analysis and corrective action system; also sufficient to accomplish timely evaluation and direction of the Program's efforts in this respect.

APPENDIX II

FAILURE/MALFUNCTION REPORT — ENGINE PROGRAM - Aerojet-General Corp.

AGCS [illegible]	REPORT NO.	☐ FAILURE ☐ MALFUNCTION	☐ SIGNIFICANT ☐ NONSIGNIFICANT
VERBAL NOTIFICATION DATE	FAILURE/MALFUNCTION DATE	DATE OF DETECTION	TOP ASSEMBLY MANUFACTURER

COMPONENT/TOP ASSEMBLY	TOP ASSEMBLY PART NO.	TOP ASSEMBLY SERIAL NO.
PART NAME	PART NO.	SERIAL NO.
PART MANUFACTURER	IR NO. AND DATE	TENTATIVE DISPOSITION *
TEST SPEC. OR PROCEDURE NO.	TYPE OF TEST ☐ DEVELOPMENT ☐ ACCEPTANCE ☐ QUAL	TEST LOCATION

FAILURE OR MALFUNCTION DESCRIPTION

SPECIFICATION PERFORMANCE REQUIREMENTS NOT MET.

MISSION EFFECT ☐ ABORT ☐ PERFORMANCE DEGRADATION ☐ NO SIGNIFICANT EFFECT ☐ INITIAL ACCEPT. TEST-N/A

OPERATIONAL USEAGE (TIME CYCLE HISTORY)

DATE	REPORTED BY

* NOTE: DISPOSITION SUBJECT TO CHANGE ON FINAL INSPECTION REPORT

Figure 1

APPENDIX II

FAILURE ANALYSIS — Aerojet-General Corp.

AGCS 0702 (REV. 10-67)

		ANALYSIS DATE	FAILURE REPORT NO	FAILURE ANALYSIS REPORT NO
PART NO.	SERIAL NO	COMPONENT	MANUFACTURER	

DESIGN/DEVEL. ENGIN.	ENGINEERING APPROVAL	RELIABILITY APPROVAL	
NAME	NAME	NAME	
SIGNATURE	SIGNATURE	SIGNATURE	

Figure 2

APPENDIX II

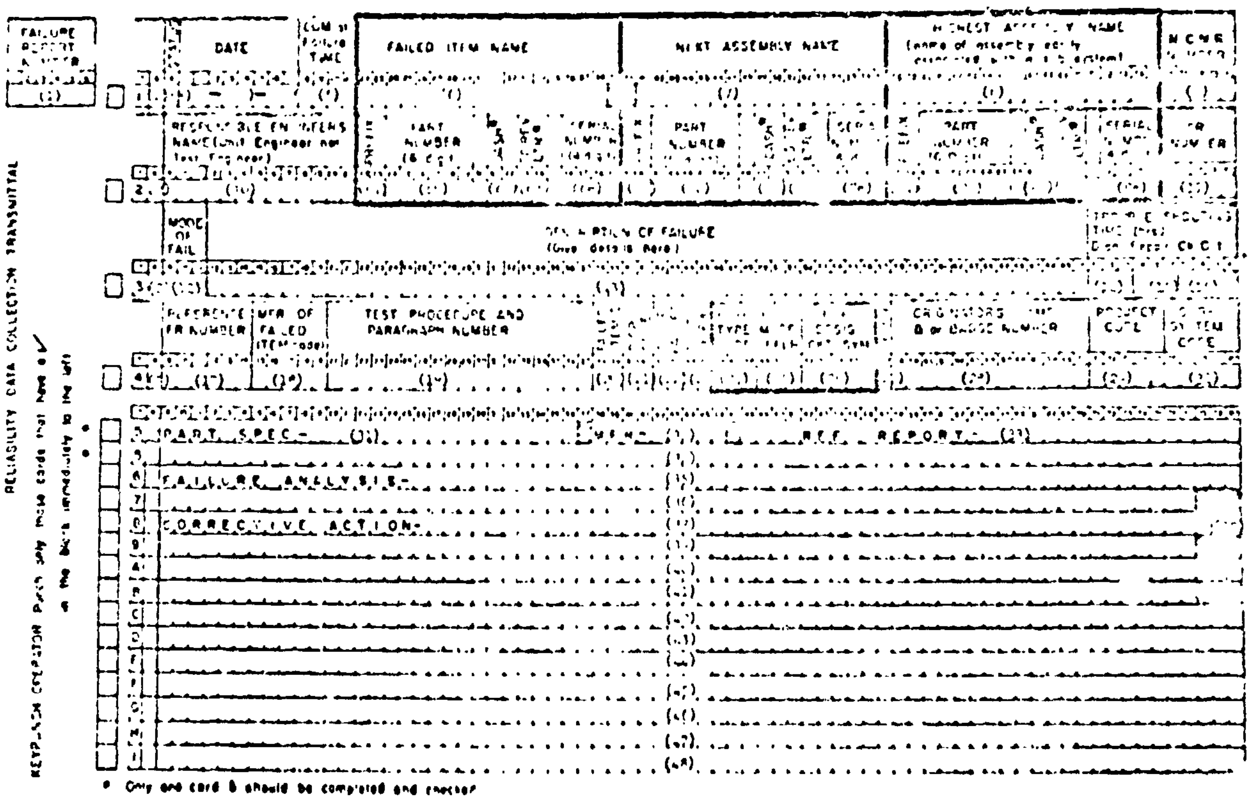


Figure 3

NERVA PROGRAM RELIABILITY PROCEDURE	NUMBER: R101-NRP-704	REVISION
	EFFECTIVE DATE:	CATEGORY III
PARTS AND MATERIAL DATA SELECTION AND CONTROL SYSTEM	SUPERSEDES: NUMBER: DATE:	
	APPROVED BY: W. M. Bryan	

CONTENTS

CONTENTS (cont.)

CONTENTS (cont.)

1.0 PURPOSE

1.1 This document establishes the minimum requirements for parts and material data selection and control for use in the NERVA engine. These requirements encompass parts selection, quality and reliability assurance requirements, specifications, procurement, and failure analysis.

1.2 This document will promote, encourage, and ensure the selection and use of parts that will complement and contribute to the accomplishment of the mission of the NERVA engine.

2.0 APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposals shall apply:

Specifications

Military

MIL-T-27	Transformers and Inductors (Audio, Power, and High Power Pulse) General Specification for
MIL-C-15305	Coils, Radiofrequency; and Transformers, Intermediate and Radio-frequency; General Specification for
MIL-F-15733	Filters, Radio Interference, General Specification for
MIL-C-18388	Coils, Tube Deflection; and Coils, Tube Focusing
MIL-T-21038	Transformers, Pulse, Lower Power, General Specification for
MIL-F-39025	Filters; High Pass, Low Pass, Band Pass, Band Suppression, and Dual Functioning, Established Reliability, General Specification for
MIL-C-55189	Coils, Radiofrequency, Intermediate and Radiofrequency Transformers Microelements, Inductive

2.0. Applicable Documents (cont.)

George C. Marshall Space Flight Center

MSFC-SPEC-339	Relays, DC, Hermetically Sealed, for Space Vehicles and Ground Support Equipment, General Specification for

Standards

Military

MIL-STD-202	Test Methods for Electronic and Electrical Components Parts
MIL-STD-1470	Guided Missile Preferred Items List, Electronic and Electromechanical
MIL-STD-1471	Guided Missile Preferred Items List, Mechanical and Materials
MS33586	Metals, Definition of Dissimilar

George C. Marshall Space Flight Center

MSFC-STD-355	Radiographic Inspection of Electronic Parts

Drawings

George C. Marshall Space Flight Center

85M02704	Microcircuits, Quality Assurance and Screening Requirements for, High Reliability
85M02706	Microcircuits, High Reliability Qualified Products List
85M02713	Discrete Semiconductor Devices, Quality Assurance and Screening Requirements for, High Reliability
85M02716	Preferred Electrical Parts List for AAP (Formerly Preferred Electrical Parts and Materials List for ATM)
85M03877	Microcircuits, Line Certification Requirements for
85M03926	Design and Quality Standards for Custom Hybrid Microcircuits
85M03927	"Carrier Mounted" Chip Devices, Specification for

2.0, Applicable Documents (cont.)

Publications (Government)

National Aeronautics and Space Administration

NASA TM X-53328	Terrestrial Environment (Climatic) Criteria Guidelines for Use in Space Vehicle Development, 1966 Revision
NASA TM X-53798	Space Environment Criteria Guidelines for Use in Space Vehicle Development, 1968 Revision

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the printing activity or as directed by the contracting officer.)

3.0 POLICY

The requirements of this document will apply for all NERVA engine components.

4.0 DEFINITIONS

4.1 PART

One piece, or two or more pieces joined together which are not normally subject to disassembly without destruction.

4.2 PREFERRED PARTS

Those parts selected as preferred because of their proven quality and reliable performance, and which are qualified to the established requirements, controlled by adequate specifications which employ screening where applicable, and manufactured under an effective quality assurance system.

4.3 NONPREFERRED PARTS

All parts which do not meet the requirements of preferred parts are considered as nonpreferred. This does not preclude their use provided they meet selection and control requirements established by this document.

4.4 ELECTRICAL PARTS

Items designed to be used in electronic or electrical circuits. Some examples are capacitors, resistors, relays, switches, inductors, semiconductor devices, and microcircuits.

4.0, Definitions (cont.)

4.5 MECHANICAL PARTS

Items which transmit, contain, support, or hold static or dynamic forces in mechanical systems. These parts shall include, but not be limited to, the following categories:

a. Bearings
b. Bellows
c. Fasteners
d. Filters, nonelectrical
e. Fittings, tubing and hose
f. Gaskets and seals
g. Hoses
h. Mounts, resilient
i. Tubing, casings and sleeving
j. Wire, nonelectrical (includes cables)

4.6 ELECTRO-MECHANICAL PART

An assembly of electrical and mechanical parts for providing a specific function. For the purposes of this document, these devices are considered not subject to disassembly or maintenance. Examples are gyros, synchros, accelerometers, indicating instruments, etc.

4.7 SCREENING

The application of appropriate stresses to an electrical part for the purpose of accelerating failure mechanisms to the point where they can be detected by parameter measurement or inspection.

4.8 NONDESTRUCTIVE TESTS

Tests which produce no significant evidence of cumulative degradation of any part in the sample are considered nondestructive. Some examples which are considered nondestructive for most parts are X-ray, proof pressure, seal leak, etc.

4.9 COMPONENT

A combination of parts, subassemblies, or assemblies, usually self-contained, which performs a distinctive function in the operation of the overall equipment.

4.0, Definitions (cont.)

4.10 FAILURE EFFECT CATEGORIES

4.10.1 Category I

Failures which produce no significant performance or safety degradation of the system, allow continued operation in the normal mode throughout the rated engine life, and no not result in the addition of single-failure-points to the system.

4.10.2 Category II

Failures from which the engine can recover and still meet its normal-mode performance and service life requirements by switching to or reverting to a recovery mode, but which do result in the addition of single-failure-points to the system. Failures in this category are further subdivided as follows:

4.10.2.1 Category IIA

Failures which degrade the safety of continued operations, but which do not produce transient effects and, at the time of failure, do not require automatic or manual action for the recovery mode. Failures of safety systems and standby redundant components fall within this category.

4.10.2.2 Category IIB

Failures which are compensated for automatically by the normal control mode or which produce transient effects which can be tolerated by the system and which permit time for human judgment to be exercised on the method and desirability of the recovery mode. Failures which require the functioning of safety systems or redundant components to preclude Category IIIB effects fall within this category.

4.10.2.3 Category IIC

Failures which require immediate malfunction detection and subsequent action to remove or lessen the transient effect and to preclude system damage. Switching to the recovery mode is usually accomplished automatically by the malfunction detection system or by the engine control system. Failures which require the automatic functioning of safety systems or redundant components to preclude Category IV effects fall within this category.

4.10.3 Category III

Failures which result in inability of the engine to meet its normal-mode performance or service-life requirements but which allow emergency mode operation or single turbopump operation. Failures in this category are further subdivided as follows:

4.10.3 Failure Effect Categories (cont.)

4.10.3.1 Category IIIA

Failures which require single turbopump operation.

4.10.3.2 Category IIIB

Failures which require emergency mode operation.

4.10.4 Category IV

Failures which result in direct injury to the crew, endanger the earth's population, or damage the spacecraft or other stage modules upon which crew survival depends and/or which preclude emergency mode operation. This category includes failures which produce one or more of the following system effects:

a. Uncorrected thrust vector misalignment.
b. Loss of thrust to less than that required to effect operation in the emergency mode.
c. Inability to reduce thrust or unsuccessful shutdown and/or cooldown which precludes engine restart.

4.11 COMPONENT TYPES

Components have been classified into three types, according to their development status.

4.11.1 Type I

Type I - new component design. This includes the new design portions of existing components.

4.11.2 Type II

Type II - component design is established and qualified from previous programs but the equipment is not yet built.

4.11.3 Type III

Type III - component design is established and qualified from previous programs and the equipment has been manufactured and is "on the shelf."

5.0 PROCEDURE

5.1 COMPONENT TYPE CONTROL REQUIREMENTS

The requirements of this document shall apply to component Types I, II, and III and hazard categories I, IIA, IIB, IIC, IIIA, IIIB and IV.

5.1.1 Type I Components

The following control elements shall be imposed on Type I components:

a. Select and use preferred parts.
b. A list of any nonpreferred parts shall be available to SNPO-C for review.
c. Perform design application review.
d. Determine acceptability for nonpreferred parts.
e. Prepare specifications for nonpreferred parts.
f. Control procurement of preferred and nonpreferred parts.
g. Review engineering parts list.
h. Perform comprehensive receiving inspection.
i. Perform failure analysis and take corrective action.

5.1.2 Type II Components

The control elements listed below shall be imposed on Type II components. Any redesign or modification shall be treated as Type I.

a. Review failure history of components in previous programs to identify troublesome parts. Replace such parts with parts from the preferred parts list where possible, or with screened parts, or parts which have successfully completed adequate non-destructive testing.

b. Select and use preferred parts where these parts are directly interchangeable.

c. Review the parts list and identify parts that have high failure histories or may present a hazard in space flight applications. Such parts shall be replaced with parts that are more suitable.

d. A list of all nonpreferred parts shall be available to SNPO-C for review.

e. Prepare specifications for nonpreferred parts that must be procured. If the part has already been procured and is on hand, perform appropriate screening, or non-destructive testing.

f. Control procurement of preferred and nonpreferred parts.

g. Review engineering [illegible] list.

h. Perform comprehensive receiving inspection.

i. Perform failure analysis and take corrective action.

5.1, Component Type Control Requirements (cont.)

5.1.3 Type III Components

The control elements listed below shall be imposed on Type III components. Any redesign or modification shall be treated as Type I.

a. Review failure history of components in previous programs to identify troublesome parts.

b. When a troublesome or hazardous part is identified, attempts shall be made to test and screen the lowest subassembly to determine the acceptability of the part.

c. When the part cannot be tested or screened at the subassembly level or when failure is encountered at this level during the test, the part shall be replaced by a preferred or adequately tested or screened part.

d. Review engineering parts list.

e. Perform failure analysis and corrective action.

5.2 PARTS SELECTION

Design activities in cooperation with parts specialists shall establish procedures for effective control of parts selection. The selection criteria shall ensure that the minimum number of part types feasible are used. In order to accomplish this, designers are encouraged to use microcircuits to the maximum extent possible because of the advantages of their low weight, volume, and power consumption, higher level of reliability, and lower costs. Parts shall be capable of meeting the operational and environmental criteria. (The prime contractor is fully responsible for the satisfactory performance of each part in accordance with the contractual requirements, regardless of the source from which the part was selected or who wrote or approved the controlling documentation.) The flammability and outgassing properties of all parts and materials shall be considered and must comply with the requirements for the applicable system.

5.2.1 Electrical Parts Selection

Electrical parts required for use in engine shall be selected in the following order of precedence:

5.2.1.1 Electrical Preferred Parts Lists

Initial selection shall be made from MSFC Drawing 85M02716, or lists which are furnished by SNPO-C. At a later date, other lists may be supplied as requirements dictate.

5 2.1.1, Electrical Preferred Parts Lists (cont.)

5.2.1.2 Nonpreferred Parts

a. Monolithic Microcircuits. When the contractor's design cannot be satisfied by microcircuits on the preferred list, he shall select other microcircuits whose designs through use, experience, and tests, are shown capable of meeting his needs. Specifications (Paragraph 4.4) shall be prepared for these parts and they shall be purchased only from manufacturers whose lines have been certified in accordance with MSFC Drawing 85M03677, and are listed in the Certified Lines List of MSFC Drawing 85M0272+, and for the process steps for which the manufacturer has certification. When a microcircuit manufacturer with a certified line cannot be found, SNPO-C shall be notified (Paragraph 6.1) in order that action may be taken to certify the lines.

b. Microcircuits, hybrid. All hybrid microcircuits that can be classified as custom designs shall be designed, manufactured, inspected, and tested in accordance with MSFC Drawing 85M03926, and designs that use "carrier mounted" chip devices shall be in accordance with MSFC Drawing 85M03927.

c. All other nonpreferred electrical parts shall be selected using criteria in the order of precedence shown.

(1) Parts previously qualified for use in the space and terrestrial environments or equivalent requirements.

(2) Parts previously qualified in other programs on which there is considerable data that demonstrates conformance with similar requirements.

(3) Parts listed in MIL-STD-1470.

(4) Parts listed in the contractor's preferred parts lists and are suitable for the equipment.

(5) Other sources as necessary.

Nonpreferred parts shall be selected with exacting consideration given to the inherent capability of the parts to withstand the space and terrestrial environments and assurance of adequate controls. Each nonpreferred part used shall be available to SNPO-C for review.

5.2.2 Mechanical Parts Selection

Mechanical parts selection for the NERVA engine shall, as a minimum, consider the following requirements:

5.2.2.1 Mechanical Preferred Parts

Mechanical parts and fasteners should be selected from MSFC Document MSFC-PPD-600, Volume II, "Preferred Parts, Mechanical"; Military Sheet Standards (MS); MIL-STD-1.71; and Air Force-Navy (AN) Standards whenever practical. Mechanical parts and fasteners which are not available in the foregoing standards may be selected from equivalent standards provided test data and experience have been obtained which verifies compliance with the requirements imposed herein.

5.2.2, Mechanical Parts Selection (cont.)

5.2.2.2 Workmanship

Mechanical parts should be constructed and finished utilizing manufacturing processes that will ensure a quality product. Visual inspection should not reveal defective plating or painting, deformed rivets, incomplete welded or brazed joints, machining burrs or slivers, and inadequate or illegible part marking.

5.2.2.3 Dissimilar Metals

Dissimilar metals, as defined in MS33586, should not be used in combination unless they are suitably protected to prevent electrolytic corrosion.

5.2.2.4 Corrosion of Metal Parts

The NERVA engine mechanical parts should be constructed of metallic materials or materials with proven corrosion resistance characteristics. Metal parts should be protected from corrosion by stress-relieving, plating, anodizing, chemical coatings, organic finishes, or combinations thereof provided that such protection is compatible with the operating environment requirements as defined in TM X-53328 and TM X-53798.

5.2.2.5 Moisture and Fungus Resistance

Except as otherwise required by detail design considerations, only materials which resist damage from moisture and fungus should be used.

5.2.2.6 Meteoroid Protection

Parts must be capable of withstanding or be provided protection from meteroid penetration when subjected to the meteroid flux model specified in TM X-53798.

5.2.2.7 Lubrication

Lubricants used in mechanical and electro-mechanical parts not hermetically sealed should be suitable for use in the space environment as defined in TM X-53798. Sliding or rotating bearing surfaces not normally lubricated should not produce excessive friction or degrade in a hard vacuum environment.

5.3 PARTS LISTS

Parts lists shall be submitted to SNPO-C that will be suitable for technical review. Two types of lists are required; the nonpreferred parts list and the engineering parts list.

5.3.1 Nonpreferred Parts List

A listing of all nonpreferred parts proposed for use shall be available for SNPO-C review. This listing shall include part identification, application, controlling documentation including all existing documents and engineering orders, and probable sources.

5.3.2 Engineering Parts List

Prior to design release to fabrication, the contractor shall compile and have available for SNPO-C review an engineering parts list containing all parts used, both preferred and nonpreferred. This parts list is the same as that required by documentation standards for good engineering practice and does not constitute an additional documentation requirement. All nonpreferred parts on this list shall be identifiable on the nonpreferred parts list described in Paragraph 5.3.1. Changes shall be compiled and supplementary submission made each month to SNPO-C.

5.4 SPECIFICATIONS

Maximum use will be made of the specifications listed in the preferred parts lists. In addition to the preferred parts specifications, maximum use will be made of other appropriate specifications. For all nonpreferred parts for which an adequate specification cannot be found, specification shall be proposed including the following criteria, as a minimum:

a. Complete identification of the part.

b. Physical (including marking), environmental, and performance requirements.

c. Quality and reliability assurance requirements including, when applicable, screening, non-destructive tests, workmanship, inspections, and electrical and environmental tests for qualification and acceptance.

5.5 PARTS QUALIFICATION

Parts shall be used which are qualified for the application, based on existing data, similarity, or higher level of assembly testing.

5.5, Parts Qualification (cont.)

5.5.1 Existing Data

Data on identical parts which applies to part tests performed at stresses equal or greater than those anticipated and available from the Interagency Data Exchange Program (IDEP), Military, or contractor testing may be used to establish acceptable qualification.

5.5.2 Similarity

Qualification by similarity may be acceptable if the similar part is of similar design, procured to equivalent specifications, fabricated by the same manufacturer using the same processes and quality controls, and the performance differences are identifiable, measurable, and not great enough to invalidate the similar testing data.

5.5.3 Higher Level of Assembly

Qualification testing of a higher assembly may be acceptable if it is restricted to the specific part application within that assembly, the assembly is qualified by test, qualification can best be demonstrated at this level because of the specific application of the part, and the assembly level represents a reasonable balance between application, usage, test objectives, facility availability, and schedule requirements. This level of testing does not qualify the part for other applications. If adequate test data are not available in any of the above categories, qualification by test may be necessary.

5.6 PARTS SCREENING REQUIREMENTS

Screening tests shall be performed on each electrical and electronic part in Criticality Categories I, IIA, IIB, IIC, III, and IV hardware. Where existing specifications do not impose adequate screening requirements or new specifications are required, the following documents and recommendations shall be imposed with additions as required to assure reliable parts for the application. The following requirements and documents are not to be used when an approved specification exists:

5.6.1 Diode, Transistor, and Rectifier Screening

Diode, transistor, and rectifier screening shall be accomplished in accordance with 85M02713.

5.6.2 Microcircuit Screening

Microcircuit screening shall be accomplished in accordance with 85M02704.

5.6, Parts Screening Requirements (cont.)

5.6.3 Capacitor Screening

Capacitor screening shall be accomplished in accordance with the requirements of Appendix A.

5.6.4 Resistor Screening

Resistor screening shall be accomplished in accordance with the requirements of Appendix B.

5.6.5 Relay Screening

Relay screening shall be accomplished in accordance with the requirements of Appendix C.

5.6.6 Electromagnetic Part Screening

Electromagnetic part screening shall be accomplished in accordance with the requirements of Appendix D.

5.7 PROCUREMENT

Preferred parts shall be procured only from sources listed in the applicable qualified products list (QPL), and in accordance with the requirements of the applicable specifications. When a new source is considered, this source must be qualified. Similar QPL's shall be established and utilized to procure non-preferred parts. All sources of supply selected shall be available to SNPO-C for review.

5.8 PARTS AND MATERIALS PROBLEMS

Problems with parts and materials such as failures or discrepant conditions, which are of mutual concern to SNPO-C and contractors, are reported utilizing the ALERT system.

5.8.1 ALERT System

Alerts are issued in two categories, i.e., one type which requires action by SNPO-C and the contractor and one type which is sent for information only and requires no action by the contractor.

a. Action ALERT. When identified by the title "ALERT" only, action is required by the contractor. The following steps shall be performed to support the ALERT system:

(1) Maintain adequate records to assess ALERT's.

(2) Respond to action ALERT's within seven days of receipt, identifying specific applications, stating the extent of applicability of the ALERT, quantity of the subject parts used, and where used.

5.8.1, ALERT System (cont.)

(3) Conduct the necessary engineering analysis to determine the action to be taken and within three weeks of receipt of the ALERT, submit to SNPO-C the results of the analysis, and action taken, and further actions necessary to correct any discrepancies or eliminate potential problems related to the subject of the ALERT.

(4) Participate in the NASA ALERT system through the initiation of reports to SNPO-C concerning significant parts or materials problems detected.

b. ALERT (Information only). When identified by the statement "sent for information only, no action required", SNPO-C considers that the problem has no impact on the program. The information only ALERT is sent to the contractor to make him aware that a problem exists. However, if the contractor determines that the problem does have an impact on the program, he shall immediately report this to the contracting officer.

5.9 FAILURE ANALYSIS

A failure analysis of all parts which fail shall be conducted in accordance with NRP-XXX (Failure Analysis).

5.10 PARTS APPLICATION REVIEW

During design review, a thorough parts application review shall be conducted to determine the applicability of each part in the design to the mission profile requirements in order to assure that the part is not used in a manner that will contribute to performance degradation or failure. The parts application review shall be thoroughly documented and shall be considered a checklist item in the design review. Within 30 days of completion of each parts application review, documentation shall be made available for review by SNPO-C. The contractor shall take immediate action to correct any deficiencies brought out in the review.

5.11 RECEIVING INSPECTION

Inspections and tests on all procured parts shall be performed to verify conformance to the requirements of the controlling documentation. Operations performed at receiving inspection shall include the following:

a. Verification that documentation required to perform the inspection is available.

b. Inspect supplier documentation for accuracy and adequacy.

c. Check for shipping damage and count.

d. Perform inspection in accordance with inspection procedures.

5.11, Receiving Inspection (cont.)

e. Utilize only calibrated measuring equipment.
f. Perform required tests and record the data.
g. Assign lot number as required.
h. Attach age control stickers as required.
i. Accept or reject parts.
j. Accept or reject nonfunctional parameters.
k. Complete records and file or forward data as required.
l. Forward accepted parts to stock; forward rejected parts for disposition.

5.12 PARTS IDENTIFICATION

Each part shall, as a minimum, be permanently identified by the part number, manufacturer, lot number or date code, and a symbol indicating successful completion of screening tests are required.

5.12.1 Identification and Traceability of Parts

All parts shall be so identified and documented that they will be traceable to a specific manufacturer and lot number or date code. Additionally, mechanical parts utilized in critical structures should be purchased in distinct production lots or batches, identified as critical piece parts and segregated from other lots of similar parts.

5.13 CONTRACTOR COMPLIANCE PLAN

The Reliability Plan shall describe the plan for compliance with each requirement of this document.

5.14 DEVIATION OR WAIVERS

Any deviations from the above requirements shall be brought to the attention of the contracting officer or his representative immediately and may be resolved only by SNPO-C directive or waiver.

APPENDIX A

MINIMUM SCREENING REQUIREMENTS FOR CAPACITORS

1.0 CAPACITOR SCREENING

Capacitor Screening shall be accomplished in accordance with Table I and the applicable paragraphs specified herein.

1.1 TANTALUM CAPACITORS

1.1.1 Burn-In

a. Non-Solid - 100 per cent of rated voltage, at 85°C ambient for 250 $^{+12}_{-0}$ hours.

b. Solid - 100 per cent of rated voltage, at 125°C ambient for 48 $^{+8}_{-0}$ hours.

NOTE

Maximum circuit impedance (excluding capacitor) shall be 10 ohms for non-solid and 3 ohms for solid tantalum capacitors.

1.1.2 DC Leakage

a. Non-Solid - DC leakage shall be measured at room ambient and at 85°C within 5 minutes after the capacitors have been connected across a source of the rated voltage. For nonpolar capacitors, measurements shall be made in both directions.

b. Solid - DC leakage shall be measured using the DC rated voltage ± 2 per cent at 85°C after a maximum electrification period of 5 minutes. A 1,000-ohm resistor shall be placed in series with the capacitor to limit the charging current. A steady source of power, such as a regulated power supply, shall be used. Measurement accuracy shall be within ± 2 per cent or 0.02 microampere (uA), whichever is greater.

1.1.3 Capacitance

Capacitors shall be tested in accordance with method 305 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test frequency - 120 ± 5 hertz.

b. Limit of accuracy - Measurement accuracy shall be within ± 2 per cent of the reading.

c. Magnitude of polarizing voltage - Maximum DC bias shall be 2.2 volts for all AC measurements of polarized capacitors. The magnitude of the AC voltage shall be limited to 1.0 volt rms.

TABLE I

SCREENING REQUIREMENTS/APPLICABLE PARAGRAPHS

Dielectric Type	Burn-In	Capacity	Dissipation or Power Factor	Dielectric Withstanding Voltage	DC Leakage or Insulation Resistance	X-Ray	Seal	Visual & Mech.
Tantalum Non-Solid	1.1.1(a)	1.1.3	1.1.4	Omit	1.1.2(a)	1.16	1.1.5(a)	1.9
Tantalum Solid	1.1.1(b)	1.1.3	1.1.4	Omit	1.1.2(b)	1.1.6	1.1.5(b)	1.9
Ceramic Non-Herm.	1.2.1	1.2.3	1.2.4	1.2.2	1.2.5	Omit	Omit	1.9
Plastic Non-Herm.	1.3.1	1.3.3	1.3.4	1.3.2	1.3.5	1.3.6	Omit	1.9
Paper Herm.	1.4.1	1.4.6	1.4.7	1.4.4	1.4.5	1.4.2	1.4.3	1.9
Plastic Herm.	1.5.1	1.5.6	1.5.7	1.5.4	1.5.5	1.5.2	1.5.3	1.9
Glass Herm.	1.6.1	1.6.4	1.6.5	1.6.2	1.6.3	Omit	Omit	1.9
Mica	1.7.2	1.7.4	1.7.5	1.7.1	1.7.3	Omit	Omit	1.9
Variable	1.8.5	1.8.1	1.8.4	1.8.3	1.8.2	Omit	Omit	1.9

1.1.4 Dissipation or Power Factor

The dissipation factor of each capacitor shall be measured at a frequency of 120 ± 5 hertz by means of a polarized capacitance bridge. The bridge shall provide a dial reading accuracy of 0.1 per cent dissipation factor and a measuring accuracy of ± 2 per cent of the measured dissipation factor plus 0.1 per cent.

1.1.5 Seal

a. Non-Solid

(1) Each capacitor shall be subjected to one (1) of the following conditioning tests:

(a) Temperature cycle in accordance with method 102 of Standard MIL-STD-202, for a total of ten (10) cycles, performed continuously at test condition C.

(b) Thermal vacuum bake at 125°C and 10^{-3} torr for 24 hours.

(2) After above conditioning, test each capacitor for electrolyte leakage by one (1) of the following methods:

(a) Apply Thymol Blue (0.04 per cent) indicator to each capacitor around the cover seal and lead wire of anode. Evidence of electrolyte leakage will be indicated by change of color of Thymol Blue from yellow to red. Remove the Thymol Blue with deionized water rinse.

(b) Test with moistened blue litmus paper.

b. Solid

Capacitors shall be tested in accordance with method 112 of Standard MIL-STD-202, test condition letter A.

1.1.6 X-Ray

Per MSFC-STD-355.

1.2 CERAMIC CAPACITORS

1.2.1 Burn-In

a. 48^{+8}_{-0} hours.

b. 125°C ambient.

c. Capacitors rated above 1,000 VDC, 100% of rated voltage. Capacitors rated 1,000 VDC, or less, 200 per cent of rated voltage.

1.2.2 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with method 301 of Standard MIL-STD-202. The following details shall apply:

a. Magnitude and nature of test voltage - Capacitors rated above 500 VDC, 175 per cent of rated voltage. Capacitors rated 500 VDC or less, 250 per cent of rated voltage.

b. Duration of application of test voltage - 5 $\pm$ 1 seconds.

c. Points of application of test voltage - Unless otherwise specified, between the capacitor-element terminals.

d. Limiting value of surge current - Shall not exceed 50 milliamperes (mA).

e. Examination after test - Capacitors shall be examined for evidence of damage and breakdown.

1.2.3 Capacitance

Capacitors shall be tested in accordance with method 305 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test frequency - Unless otherwise specified, 1 megahertz $\pm$ 100 kilohertz when the nominal capacitance is 100 pF or less, and 1 kilohertz $\pm$ 100 hertz when the nominal capacitance is greater than 100 pF.

b. Voltage - Unless otherwise specified, root-mean-square potential of 2 $\pm$ 1 volts shall be maintained within $\pm$ 0.5 volt throughout the measurement.

1.2.4 Dissipation Factor

Unless otherwise specified, dissipation factor shall be measured at the frequency and voltage specified in 1.2.3.

1.2.5 Insulation Resistance

Capacitors shall be tested in accordance with method 302 of Standard MIL-STD-202. The following details shall apply:

a. Test Voltage - Rated DC voltage as a minimum.

b. Electrification time - 5 seconds minimum.

c. Surge current limit - 50 mA.

d. Points of measurement - Unless otherwise specified, between the mutually insulated points.

1.3 PLASTIC, NON-HERMETICALLY SEALED CAPACITORS

1.3.1 Burn-In

a. 48 $^{+8}_{-0}$ hours.

b. 125°C ambient.

c. 100 per cent of rated voltage.

d. Surge current limited to 1 ampere maximum.

1.3.2 Dielectric Withstanding Voltage

The dielectric withstanding voltage test shall be performed in accordance with method 301 of Standard MIL-STD-202. Unless otherwise specified, test voltage to be 400 per cent of rated DC voltage for a period of 15 seconds. Surge current shall be limited to 1 ampere.

1.3.3 Capacitance

Capacitors shall be tested in accordance with method 305 of Standard MIL-STD-202. The following details shall apply:

a. Test frequency - 1,000 ± 100 hertz.

b. Measurement accuracy - Shall be within ± 1 per cent.

1.3.4 Dissipation Factor

The dissipation factor of each capacitor shall be measured at an AC voltage not greater than 20 per cent of the rated DC voltage, at a frequency of 1,000 ± 100 hertz. Measurement accuracy shall be within ± 2 per cent.

1.3.5 Insulation Resistance

Capacitors shall be tested in accordance with method 302 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test potential - Rated DC voltage.

b. Terminal to terminal - Insulation resistance shall be measured between terminals at a temperature of 25° ± 3°C or corrected thereto per table II, and at 125° ± 3°C.

TABLE II

INSULATION RESISTANCE CORRECTION FACTORS

Degrees C	Correction Factor
20	1.4
21	1.3
22	1.2
23	1.1
24	1.0
25	1.0
26	0.94
27	0.87
28	0.82
29	0.76
30	0.71
31	0.67
32	0.63
33	0.59
34	0.55
35	0.51

1.3.6 X-Ray

Per MSFC-STD-355.

1.4 PAPER (PAPER-PLASTIC OR PLASTIC DIELECTRIC,) HERMETICALLY SEALED CAPACITORS

1.4.1 Burn-In

a. 48 $^{+8}_{-0}$ hours.

b. 125°C ambient.

c. 100 per cent rated voltage.

1.4.2 X-Ray

Per MSFC-STD-355.

1.4.3 Seal

Capacitors shall be tested in accordance with method 112 of MIL-STD-202. The following details shall apply:

a. Test condition letter - A.

b. Examination after test - Capacitors shall be visually examined for evidence of leakage.

1.4.3.1 Liquid filled capacitors may be tested as follows:

Capacitors shall be placed with the terminals facing sideways (not upward) on a clean sheet of absorbent paper and exposed to a case temperature within $^{+3}_{-0}$°C of the applicable maximum rated temperature for a minimum of 1 hour. After the test, capacitors shall be visually examined for evidence of leakage of liquid or filling compound, or bubbles from the seal.

1.4.4 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with method 305 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Magnitude of test voltage - As specified in Table III.

b. Nature of potential - DC.

c. Duration of application of test voltage - As specified in Table III.

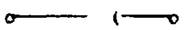
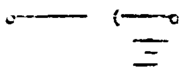
d. Points of application of test voltage - As specified in Table III.

e. Examination after tests - Capacitors shall be visually examined for evidence of breakdown, arcing, or other visible damage.

1. The capacitors shall be subjected, at the option of the manufacturer, to the application of 250 per cent of rated DC voltage for not less than 5 seconds, or 200 per cent for not less than 15 seconds.

2. For quality conformance inspection, applications of potential may be made between each terminal individually and the case.

TABLE III

Circuit-diagram symbol	Circuit diagram	Test points	Magnitude of test voltage	Duration of application of voltage
			Per cent rated DC voltage	Minutes
1 - - -		Terminal to terminal	1/ 200	1/ 1
		Terminal to case 2/	200	
3 - - -		Terminal to terminal	1/ 200	1/ 1

1.4.5 Insulation Resistance

Capacitors shall be tested in accordance with method 302, MIL-STD-202. The following details and exceptions shall apply:

a. Test potential - A potential equal to the rated DC voltage or 500 VDC, whichever is less.

b. Points of measurement.

(1) Terminal to terminal - Insulation resistance shall be measured between terminals at the maximum rated temperature, ± 3°C, and at 25 ± 3°C or corrected thereto.

(2) Terminals to case - When the case is not a terminal, the measurement shall be made between each terminal and the case at 25°C.

c. Time constant - The time constant of the measurement circuit with the capacitor connected shall not exceed 30 seconds.

d. Surge current limit - Not to exceed 1 ampere.

1.4.6 Capacitance

Capacitors shall be tested in accordance with method 305 of Standard MIL-STD-202. The following details shall apply:

a. Test frequency - 1,000 ± 100 hertz.

b. Limit of accuracy - Shall be within ± 0.5 per cent.

1.4.7 Dissipation Factor

The dissipation factor of capacitors shall be measured at an AC voltage not greater than 2? per cent of the rated DC voltage and at a frequency of 1,000 ± 100 hertz. Measurement accuracy shall be within ± 2 per cent.

1.5 PLASTIC, HERMETICALLY SEALED CAPACITORS

1.5.1 Burn-In

a. 48 $^{+8}_{-0}$ hours.

b. 125°C ambient.

c. 100 per cent of rated voltage.

1.5.2 X-Ray

Per MSFC-STD-355.

1.5.3 Seal

Capacitors shall be tested in accordance with Method 112 of Standard MIL-STD-202, Test condition A.

1.5.3.1 Liquid filled capacitors may be tested as follows: Capacitors shall be placed with terminals facing sideways (not upward) on a clean sheet of absorbent paper and exposed to a case temperature within $^{+3}_{-0}$°C of the applicable maximum rated temperature for a minimum of 1 hour. After the test, the capacitors shall be visually examined for evidence of leakage of liquid or bubbles from the seal.

1.5.4 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test voltage - 200 per cent of rated DC voltage.

b. Duration of test voltage - 5 seconds.

c. Limiting value or surge current - Shall not exceed 1.0 ampere.

d. Points of application of test voltage - Between leads or between leads and case, whichever is applicable.

1.5.5 Insulation Resistance

Capacitors shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

a. Magnitude of test voltage - Rated DC voltage.

b. Points of measurements - Measurements shall be made between terminals at 25° ± 3°C and between terminals to case when the case is not a terminal.

1.5.6 Capacitance

Capacitors shall be tested in accordance with Method 305 of Standard MIL-STD-202. The following details shall apply:

a. Test frequency - 1,000 ± 100 hertz for capacitors having a nominal capacitance of 1uF or less, and 60 ± 6 hertz for capacitors having a capacitance greater than 1uF.

b. Limit of accuracy - Within ± 2 per cent.

1.5.7 Dissipation Factor

The dissipation factor shall be measured at a temperature of 25° ± 3°C at a voltage not greater than 5 per cent of the rated voltage. Test frequency shall be as specified in paragraph 1.5.6.

1.6 GLASS (HERMETICALLY SEALED) CAPACITORS

1.6.1 Burn-In

a. 48^{+6}_{-0} hours.

b. 125°C ambient.

c. 300 per cent of rated voltage.

d. Capacitors shall be protected against voltage surges of 10 per cent or more of the test voltage.

1.6.2 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply:

a. Magnitude and nature of test potential - 300 per cent of the DC rated voltage.

b. Duration of application of test voltage - Not less than 1 second nor more than 5 seconds.

c. Points of application of test voltage - Between the terminals.

d. Limiting value of surge current - Not to exceed 50 milliamperes.

1.6.3 Insulation Resistance

Capacitors shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details and exceptions shall apply:

Test potential - Not to exceed the DC rated voltage.

b. Duration of application of test voltage - 5 seconds minimum.

c. Points of measurements - From terminal to terminal.

d. Test temperature - 25°C.

e. Limiting value of surge current - Not to exceed 50 milliamperes.

1.6.4 Capacitance

Capacitance shall be measured in accordance with Method 305 of Standard MIL-STD-202. The following details shall apply:

a. Test frequency - 1 megahertz ± kilohertz when nominal capacitance is 1,000 pF or less, and 1 kilohertz ± 50 hertz when the nominal capacitance is greater than 1,000 pF.

b. Limits of accuracy - Shall be ± 0.2 per cent of nominal capacitors value or ± 0.2 pF, whichever is less.

1.6.5 Dissipation Factor

Dissipation factor shall be measured at a frequency of 1 kilohertz ± 100 hertz. Measurement accuracy shall be within ± 2 per cent or 0.005, whichever is greater.

1.7 MICA CAPACITORS

1.7.1 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply:

a. Magnitude of test voltage - 300 per cent of the rated DC voltage.

b. Duration of application of test voltage - not less than 1 or more than 5 seconds. The duration of the test shall begin when 95 per cent of the test potential is reached.

c. Points of application of test voltage - Between terminals.

d. Limiting value of surge current - Shall not exceed 5 millamperes during charging and discharging.

e. Examination after test - Evidence of damage, arcing or breakdown.

1.7.2 Burn-In

a. $48 \begin{smallmatrix}+8\\-0\end{smallmatrix}$ hours.

b. 125°C ambient.

c. 300 per cent of rated voltage.

d. Capacitors shall be protected against voltage surges of 25 per cent or more of the test voltage

1.7.3 Insulation Resistance

Capacitors shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details shall apply:

a. Test condition - A at 25 ± 5°C.

b. Points of measurement - From terminal to terminal.

c. Electrification time - Not less than 10 seconds or more than 2 minutes.

d. Limiting value of surge current - Not to exceed 5 milliamperes.

1.7.4 Capacitance

Capacitors shall be tested in accordance with Method 305, Standard MIL-STD-202. The following details shall apply:

a. Test frequency - 1 megahertz ± 1 kilohertz when the nominal capacitance is 1,000 pF or less, and 1 kilohertz ± 100 hertz when the nominal capacitance is greater than 1,000 pF.

b. Limit of accuracy - Shall be ± 0.2 per cent of the nominal capacitance value or 0.2 pF, whichever is greater.

1.7.5 Dissipation Factor

Dissipation factor shall be measured at a frequency of 1 megahertz ± 1 kilohertz when the nominal capacitance is 1,000 pF or less, and 1 kilohertz ± hertz when the nominal capacitance is greater than 1,000 pF. Measurement accuracy shall be within ± 2 per cent for dissipation factor and within ± 5 hertz for frequency.

1.8 VARIABLE CAPACITORS

1.8.1 Capacitance

Capacitors shall be tested in accordance with Method 305 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test frequency - 1 megahertz ± 100 hertz.

b. Limit of accuracy - Within ± 1 per cent or 0.5 pF, whichever is smaller.

1.8.2 Insulation Resistance

Capacitors shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test voltage - Rated DC voltage.

b. Special conditions - Measurements shall be made at 25 ± 5°C and at the applicable high test temperature.

c. Points of measurement - Between mutually insulated points.

d. Electrification time - 10 seconds to 2 minutes.

e. Limiting value of surge current - not to exceed 5 milliampere.

1.8.3 Dielectric Withstanding Voltage

Capacitors shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply.

a. Test voltage - 200 per cent of DC rated voltage.

b. Points of application of test voltage - Capacitors shall be set at maximum rated capacitance and the potential applied between the terminals.

c. Duration of test voltage - 1 to 5 seconds.

1.8.4 Quality Factor

Capacitors shall be tested in accordance with Method 306 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test frequency - Capacitors shall be set at maximum rated capacitance and Q measured at a frequency of 20 megahertz ± 200 kilohertz.

b. Measurements - Shall be made using a test jig designed for minimum stray capacitance effects.

c. Measurement accuracy - Shall be within ± 20 per cent.

1.8.5 Rotational Life

Capacitors shall be mounted with the adjusting screw set at approximately 20 per cent of maximum rated capacitance. Contact resistance shall be measured between the rotor screw and the mounting base at any position before and after the test. The screw shall be rotated four complete revolutions in the direction of increasing capacitance, then four complete revolutions in the direction of decreasing capacitance. This cycle shall be repeated 5 times. Following the final cycle, dielectric withstand voltage shall be measured. After the final measurement of contact resistance, capacitors shall be set at approximately 10 per cent of the maximum rated capacitance value above the minimum rated capacitance value or 1.0 pF, whichever is greater, and then the rotor shall be rotated in steps of two turns until 90 per cent of maximum rated capacitance is reached. A minimum of three measurements shall be made and recorded. Capacitance shall be measured after each step at a frequency between 1 kilohertz and 1 megahertz and shall be continuously monitored for reversals. The accuracy of the rotation shall be within ± 5° per revolution. Reproducibility of the measurements shall be within ± 0.1 per cent or 0.01 pF, whichever is greater. Following measurement of capacitance change versus rotation, driving torque at room ambient temperature shall be measured. The torque required to start and maintain rotation of the rotor (driving torque) shall be measured by a gradually applied force sufficient to turn the rotor through at least 50 per cent of the total number of rotations.

1.9 VISUAL AND MECHANICAL

Examine each capacitor to verify that the material, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements. After all tests required by Table I have been completed, each capacitor shall be examined for evidence of damage, arcing, breakdown, seal leaks and integrity of marking.

1.10 SCREENING IDENTIFICATION SYMBOL

After successful completion of all the applicable screening requirements of this appendix, each capacitor shall be marked with a screening identification symbol. The screening identification symbol shall be a "S" and shall precede the part number.

APPENDIX B

MINIMUM SCREENING REQUIREMENTS FOR RESISTORS

1.0 RESISTOR SCREENING

Resistor screening shall be accomplished in accordance with Tables I, II and III and the applicable paragraphs specified herein.

1.1 WIREWOUND, FIXED, POWER

1.1.1 DC Resistance

Resistors shall be tested in accordance with method 303 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Measuring apparatus - The same measuring apparatus shall be used for any one test, but not necessarily for all tests.

b. Limit of error of measuring apparatus - One-fourth of the specified initial-resistance tolerance or 0.1 per cent, whichever is less, + 0.002 ohm.

c. Test voltage - Measurements of resistance shall be made by using a DC potential resulting in not more than 1 per cent of rated wattage. This same voltage shall be used whenever a subsequent resistance measurement is made.

d. Points of application of test voltage for initial resistance tolerance measurement - For axial-lead resistors of 20 ohms or less, 3/8 ± 1/16 inch from the end of the body. For tab-terminal resistors of 20 ohms or less, locate on tab in line of hole parallel to resistor body. For all resistors above 20 ohms locate wherever practical on lead or tab.

1.1.2 Burn-In

Resistors shall be conditioned in accordance with method 108 of Standard MIL-STD-202. The following details and exceptions shall apply:

a.- Method of mounting - Supported by their terminal leads at a point 5/16-inch from the resistor body. Resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no undue draft on the resistors. If forced-air circulation is employed, the air velocity shall not exceed 500 feet per minute and there shall be no direct impingement of the forced-air supply upon the resistors.

b. Temperature and tolerance - 25° $^{+15}_{-0}$ °C.

TABLE I

FIXED RESISTORS

Screening Requirements/Applicable Paragraphs

Resistor Type	Burn-In	Thermal Shock	Temperature Cycling	Overload	DC Resistance	X-Ray	Seal	Visual & Mech.
Wirewound Fixed, Power	1.1.2	Omit	1.1.3	Omit	1.1.1	1.1.4	Omit	1.10
Wirewound Fixed Chassis Mount	1.2.2	1.2.3	Omit	Omit	1.2.1	Omit	Omit	1.10
Wirewound Fixed, Accurate	1.3.2	Omit	1.3.3	Omit	1.3.1	1.3.4	Omit	1.10
Film Fixed High Stability	1.4.2	Omit	1.4.3	1.4.4	1.4.1	1.4.6	1.4.5	1.10
Film Fixed Insulated	1.5.2	Omit	1.5.3	1.5.4	1.5.1	1.5.5	Omit	1.10
Composition Fixed, Insulated	1.6.1	Omit	Omit	Omit	1.6.2	Omit	Omit	1.10

TABLE II

VARIABLE RESISTORS

Screening Requirements/Applicable Paragraphs

Resistor Type	Burn-In	Thermal Shock	Peak Noise	Contact Resistance Variation	Insulation Resistance	Total Resistance	Seal	Visual & Mech.
Wirewound Variable	1.7.3	1.7.2	1.7.5	Omit	1.7.4	1.7.1	1.7.6	1.10
Non-Wirewound Variable	1.8.3	1.8.2	Omit	1.8.4	1.8.5	1.8.1	Omit	1.10

TABLE III

THERMAL SENSITIVE RESISTOR

Screening Requirements/Applicable Paragraphs

Resistor Type	Burn-In	Thermal Shock	Zero Power Resistance	Resistance Temperature Character	X-Ray	Visual & Mech.
Thermistor	1.9.2	1.9.3	1.9.1	1.9.4	1.9.5	1.10

c. Initial measurements - Initial resistance shall be measured as specified in 1.1.1 at $25° {}^{+15}_{-0}$ °C. This initial measurement shall be used as the reference for all subsequent measurements.

d. Operating conditions - Rated DC continuous working voltage or rated continuous working voltage from an AC supply at commercial-line frequency and waveform, shall be applied continuously for $100 {}^{+16}_{-4}$ hours. Each resistor shall dissipate a wattage equal to the wattage rating of the resistor.

e. Measurement after conditioning - Resistance shall be measured at the end of $100 {}^{+16}_{-4}$ hours as specified in 1.1.1. The same procedure for measurement shall be used for initial and final measurements.

f. Examination after conditioning - Resistors shall be examined for evidence of mechanical damage.

1.1.3 Temperature Cycling

Resistors shall be tested in accordance with Method 102 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Mounting - In such a manner that there is at least 1 inch of free air space around each resistor, and in such a position with respect to the air stream that the mounting offers substantially no obstruction to the flow of air across and around the resistors.

b. Measurement before cycling - The DC resistance shall be measured as specified in paragraph 1.1.1.

c. Test condition letter - C.

d. Climate chamber - The rate of temperature change within the climate chamber shall be not less than 2°C per minute. The temperature shall be maintained at each of the extreme temperatures by means of circulating air. The air temperature shall be measured by a suitable method and as near the center of the group of resistors as possible.

e. When two climate chambers are used - The resistors may be transferred from one chamber to another, in which case they shall be kept at room temperature for not less than 10 minutes and not more than 15 minutes between exposures to the extreme temperatures.

f. Measurement after cycling - Not less than 1 hour, but within a 24-hour period after the last cycle, DC resistance shall be measured as specified in paragraph 1.1.1.

g. Examination after test - Resistors shall be examined for evidence of mechanical damage.

1.1.4 X-Ray

Per MSFC-STD-355.

1.2 WIREWOUND, FIXED, POWER, CHASSIS MOUNTED

1.2.1 DC Resistance

As specified in paragraph 1.1.1.

1.2.2 Burn-In

As specified in paragraph 1.1.2.

1.2.3 Thermal Shock

Following a measurement of resistance, (see 1.2.1) rated voltage from an AC supply at commercial-line frequency and waveform shall be applied until thermal stability has been reached. The potential shall then be removed, and within 8 to 12 seconds, the resistors shall be subjected to an air temperature of $-55^\circ\ {}^{+0}_{-5}\ {}^\circ C$ for a period of not less than 15 minutes nor more than 30 minutes. Resistance (see 1.2.1) shall again be measured not less than 2 hours after final exposure. Resistors shall then be examined for evidence of mechanical damage.

1.3 WIREWOUND, FIXED, ACCURATE

1.3.1 DC Resistance

Resistors shall be tested in accordance with method 303 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Measuring apparatus - Bridges.

b. Limit of error of measuring apparatus - One-fourth of the specified initial-resistance tolerance or 0.1 per cent, whichever is less, + 0.002 ohm.

c. Test voltage - Measurements of resistance shall be made by using the test voltages specified in Table IV. The test voltage chosen whether it is the maximum or a lower voltage which would still provide the sensitivity required, shall be applied across the terminals of the resistor. This same voltage shall be used whenever a subsequent resistance measurement is made.

d. Points of application of test voltage for initial-resistance-tolerance measurement.

(1) Wire-lead terminal resistors of 10 ohms and less - 3/8 ± 1/16 inch from the end of the body.

(2) For resistors above 10 ohms - Locate wherever practical.

e. Temperature - For all tests, unless otherwise specified herein, the temperature at which subsequent and final resistance measurements are made in each test shall be within 2°C of the temperature at which the first resistance measurement was made.

TABLE IV

DC RESISTANCE TEST VOLTAGE

	1/2 watt and greater (Volts)	Less than 1/2 watt (Volts)
Less than 1 ohm	0.1	0.05
1 to 9.999 incl	0.3	0.15
10 to 99.99 incl	1.0	1.0
100 to 999.9 incl	3.0	3.0
1,000 to 9,999 incl	10.0	3.0
10,000 to 99,999 incl	30.0	10.0
100,000 and higher.	100.0	30.0

1.3.2 Burn-In

Resistors shall be conditioned in accordance with Method 108 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Method of mounting - Support by their terminal leads. Resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no undue draft on the resistors.

b. Temperature and tolerance - $125^{\circ}\,{}^{+15}_{-0}{}^{\circ}C$.

c. Initial measurements - At the manufacturer's option, measurements may be made inside or outside the chamber,

(1) Inside chamber - When measurements are to be made inside the chamber, the initial DC resistance shall be measured after mounting at the applicable test temperature, after temperature stabilization and within 8 hours of exposure of the resistors to the test temperature. This initial measurement shall be used as the reference temperature for all subsequent measurements under the same conditions.

(2) Outside chamber - When measurements are to be made outside the chamber the initial DC resistance shall be measured after mounting at the room temperature. This initial measurement shall be used as the reference temperature for all subsequent measurements under the same conditions.

d. Operating conditions - Rated DC continuous working voltage applied intermittently, 1 1/2 hours on, and 1/2 hour off for $100\,{}^{+16}_{-4}$ hours. Each resistor shall dissipate a wattage equal to the wattage rating of the resistor but shall not exceed maximum voltage.

e. Measurement after burn-in

(1) Inside chamber - At the end of 100 $^{+16}_{-4}$ hours and while the resistors are still in the temperature chamber, the DC resistance shall be measured.

(2) Outside chamber - When measurements are made outside the chamber, resistors shall be stabilized outside the chamber for a minimum of 45 minutes.

1.3.3 Temperature Cycling

As specified in paragraph 1.1.3.

1.3.4 X-Ray

Per MSFC-STD-355.

1.4 FILM, FIXED

1.4.1 DC Resistance

Resistors shall be tested in accordance with method 303 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Measuring apparatus - The same measuring instrument shall be used for any one test, but not necessarily for all tests.

b. Limit of error of measuring apparatus - $\pm$ (0.1 per cent + 0.01 ohm) but not exceeding one-fourth of the resistor tolerance or the resistance change limit for which the measurement is being made. Manufacturers, at their option, may use apparatus of less accuracy, provided that limits are reduced to fully compensate for accuracy deviation.

c. Test voltage - Measurements of resistance shall be made by using the test voltage specified in Table V. The test voltage chosen, whether it be the maximum or a lower voltage which would still provide the sensitivity required, shall be applied across the terminals of the resistor. This same voltage shall be used whenever a subsequent resistance measurement is made.

TABLE V

DC RESISTANCE TEST VOLTAGES

Resistance, nominal (Ohms)	1/2 watt (Volts)	1/20, 1/10, 1/8 and 1/4 watt (Volts)
10 to 98.8 incl	1	1
100 to 988 incl	3	3
1,000 to 9,800 incl	10	3
10,000 to 98,800 incl	30	10
0.1 megohm or higher	100	30

d. Temperature - The DC resistance test shall be performed at 25° $\pm$ 2°C. For all other tests, unless otherwise specified herein, the temperature at which subsequent and final resistance measurements are made in each test shall be within $\pm$ 2°C of the temperature at which the initial resistance measurements were made.

1.4.2 Burn-In

a. 100 $^{+12}_{-0}$ hours.

b. 125°C temperature.

c. Rated DC power; 1.5 hours on, 0.5 hours off.

1.4.3 Temperature Cycling

Resistors shall be tested in accordance with Method 102 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Special mounting - Resistors shall be mounted by means other than soldering or may be placed in trays. When trays are used, they must be designed to present a minimum of obstruction to the airstream. In no case shall the fixture prevent the specified ambient temperature from being achieved within 4 minutes after resistors are placed in chamber. One chamber may be used for this test.

b. Measurement before cycling - DC resistance shall be measured as specified in paragraph 1.4.1.

c. Test condition - Test condition C, except that the extreme high temperature shall be 150° $^{+0}_{-10}$°C and the extreme low temperature shall be -65° $^{+0}_{-10}$°C. These extreme temperatures shall be achieved within 4 minutes.

d. Measurement after cycling - DC resistance shall be measured as specified in paragraph 1.4.1.

e. Examination after test - Resistors shall be examined for evidence of mechanical damage.

1.4.4 Overload

Resistors shall be tested at a temperature of 25 $^{+20}_{-5}$°C at conditions specified in Table VI. When resistors are tested as specified, there shall be no evidence of arcing, burning, or charring; the change in resistance shall not exceed $\pm$ (0.25 per cent + 0.05 ohm) for temperature cycling and overload tests combined.

TABLE VI

STYLE	OVERLOAD	VOLTAGE AC or DC	DURATION
RN 50, 54, 55 57, 60	5 x Rated Power	500	1 Hr.
RN 63, 65	4 x Rated Power	600	1 Hr.
RN 70	2.25 x Rated Power	700	1 Hr.

1.4.5 Seal (Hermetically Sealed Resistor)

Resistors shall be tested in accordance with Method 112, test condition A (bubble test - mineral oil at 125°C), of Standard MIL-STD-202.

1.4.6 X-Ray

Per MSFC-STD-355.

1.5 FILM, FIXED, INSULATED

1.5.1 DC Resistance

Resistors shall be tested in accordance with method 303 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Measuring apparatus - The same measuring instrument shall be used for any one test, but not necessarily for all tests.

b. Test voltage - Measurements of resistance shall be made by using the test voltages specified in Table VII. The test voltage chosen, whether it be the maximum or a lower voltage which would still provide the sensitivity required, shall be applied across the terminals of the resistor. This same voltage shall be used whenever a subsequent resistance measurement is made.

c. Temperature - The DC resistance test shall be performed at 25° $\pm$ 2°C, unless otherwise specified.

TABLE VII

DC RESISTANCE TEST VOLTAGES

Resistance, nominal Ohms	Test potential Volts
10 to 91 incl	0.5 to 1 incl
100 to 910 incl	2.5 to 3 incl
1,000 to 9,100 incl	8 to 10 incl
10,000 to 91,000 incl	24 to 30 incl
0.1 megohm or higher	80 to 100 incl

1.5.2 Burn-In

a. 100 $^{+12}_{-0}$ hours.

b. Maximum rated temperature.

c. Rated power; 1.5 hours on, 0.5 hours off.

1.5.3 Temperature Cycling

As specified in paragraph 1.4.3, except that extreme low temperature shall be -55 $^{+0}_{-10}$°C.

1.5.4 Overload

When resistors are tested as specified below there shall be no evidence of arcing, burn burning, or charring. The change in resistance shall not exceed ± (0.5 per cent + 0.05 ohm).

a. Mounting - Resistors may be mounted in any position and allotted any size space as deemed necessary by the supplier. Forced air cooling may be used to maintain a test ambient temperature of 25° ± 10°C. The velocity of the forced air, if employed, shall not exceed 500 feet per minute. When forced air is employed, there shall be no direct impingement of the forced-air supply upon the resistors.

b. Procedure - Table VIII lists the load which shall be applied, its duration, and the maximum voltage, alternating current (AC) or DC, which may be applied to the applicable resistor style.

TABLE VIII

OVERLOAD PROCEDURE

Resistor Style	Overload and Duration	Maximum Voltage (AC or DC) Volts
RL 07	1.5 x rated power for 24 hours	250
RL 20	1.5 x rated power for 24 hours	350
RL 32	1.4 x rated power for 24 hours	500

c. Measurements - DC resistance as specified in 1.5.1 shall be measured before and after the test.

1.5.5 X-Ray

Per MSFC-STD-355.

1.6 COMPOSITION FIXED, INSULATED

1.6.1 Burn-In

a. 48^{+12}_{-0} hours.

b. Maximum rated temperature.

c. No voltage.

1.6.2 DC Resistance

Resistors shall be tested in accordance with Method 303 of Standard MIL-STD-202. The following details and exceptions shall apply.

a. Measuring apparatus - The same measuring instrument shall be used for one test, but not necessarily for all tests.

b. Combined limit of error of measuring apparatus - Shall not exceed 0.5 per cent.

c. Test voltage - Table IX gives the recommended test voltage to be impressed across the resistor.

d. Temperature - Shall be 25 $\pm$ 2°C.

TABLE IX

DC RESISTANCE TEST VOLTAGES

Resistance, nominal (Ohms)	Test potential (Volts)
2.7 to 9.1 inclusive	0.50 $\pm$ 0.1
10 to 91 inclusive	0.75 $\pm$ 0.25
100 to 910 inclusive	2.75 $\pm$ 0.25
1,000 to 9,100 inclusive	9.0 $\pm$ 1.0
10,000 to 91,000 inclusive	27.0 $\pm$ 3.0
0.1 megohm or higher	90.0 $\pm$ 10.0

1.7 WIREWOUND, VARIABLE

1.7.1 Total Resistance

Total resistance shall be measured between the resistance-element and terminals (terminals 1 and 3 of Figure B-1) and with the contact arm positioned against a stop. The positioning of the contact arm and terminal shall be the same for all subsequent measurements of the total resistance on the same specimen.

Figure B-1. CIRCUIT DIAGRAM

1.7.2 Thermal Shock

Resistors shall be tested in accordance with method 107 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter - B.

b. Measurements before cycling - Total resistance shall be measured as specified in paragraph 1.7.1 - For setting stability, the contact arm shall be set at approximately 40 per cent of the actual effective-electrical travel. An adequate DC test potential shall be applied between the end terminals. The voltage between the end terminals, and the voltage between one end terminal and the contact arm, shall be measured and applied to the following formula:

$$\text{Setting stability in per cent} = \frac{E_1 \times 100}{E_2}$$

Where:

E_1 = Voltage across one end terminal and the contact-arm terminal.

E_2 = Voltage across the end terminals.

c. Measurements after cycling - Setting stability shall be measured as specified in (b), total resistance shall be measured as specified in paragraph 1.7.1 for continuity. The lead-screw actuator shall be rotated at a uniform rate such that the wiper traverses the effective electrical travel in both directions within 1 1/4 minutes. During rotation, a suitable electrical device shall be connected between the wiper and either end terminal and monitored for smooth and unidirectional change in voltage or resistance. Precaution shall be exercised to prevent excessive current flow in the resistor during the test. There shall be no ohmmeter discontinuity upon reversal of direction of lead screw.

1.7.3 Burn-In

Resistors shall be conditioned in accordance with Method 108 of MIL-STD-202. The following details and exceptions shall apply:

a. Method of mounting - Supported by their terminals (resistor not mounted on life test chassis). Resistors shall be so arranged that the temperature of any one resistor shall not appreciably influence the temperature of any other resistor. There shall be no undue draft on the resistors.

b. Temperature and tolerance - $25° {}^{+10}_{-0}$ °C.

c. Initial measurements - Initial total resistance shall be measured after mounting at $25° {}^{+10}_{-0}$°C as specified in 1.7.1. This initial measurement shall be used as the reference temperature for all subsequent measurements.

d. Operating condition - DC continuous working voltage or a continuous working voltage from an AC supply at commercial-line frequency and waveform equivalent to 1 watt power dissipation shall be applied between the end terminals intermittently 1 1/2 hours "on" and 1/2 hour "off" for $96 {}^{+48}_{-0}$ hours at a temperature of $25° {}^{+10}_{-0}$°C. Each resistor shall dissipate 1 watt.

e. Measurement after conditioning - Total resistance shall be measured at the end of $50 {}^{+8}_{-0}$ hours as specified in 1.7.1 after load has been removed and the resistors stabilized.

f. Examination after conditioning - Resistors shall be examined for evidence of mechanical damage.

g. Test condition letter - A.

1.7.4 Insulation Resistance

Resistors shall be tested in accordance with Method 302 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter - A or B, whichever is more practical.

b. Special preparation - Resistors shall be mounted on metal plates of sufficient size to extend beyond the resistor extremities, and in such a manner that measurements can be made between the terminals tied together and any other external metal parts.

c. Points of measurements - between the terminals connected together and all external metal portions of the resistors and metal-mounting plate.

d Examination after test - Resistors shall be examined for evidence of mechanical damage.

1.7.5 Peak Noise

Peak-noise resistance shall be measured with the measuring circuit shown on Figure B-2 or its equivalent. The lead screw shall be rotated in both directions through 90 per cent of the actual effective electrical travel for a total of six cycles. Only the last three cycles shall count in determining whether or not a noise is observed at least twice in the same location. The rate of rotation of the lead screw shall be such that the wiper completes one cycle in five seconds, minimum, to two minutes, maximum. The equivalent resistance shall be calculated using the following formula:

$$\text{Noise} = \frac{E_{pn}}{0.001} \text{ ohms}$$

Where:

E_{pn} = the peak-noise signal voltage presented on the oscilloscope screen.

Figure B-2. PEAK-NOISE MEASURING CIRCUIT

1.7.6 Seal

The surface of the resistor shall be cleared of any foreign matter immediately before immersion. The bath shall consist of tap water at a temperature of 85° $^{+5}_{-0}$°C. The resistor shall be completely submerged in the bath with no part at a depth of less than 1 inch, for a period of 1 minute ± 5 seconds. During immersion, observation shall be made for any continuous visible stream of bubbles emanating from the resistors.

1.8 NON-WIREWOUND, VARIABLE

1.8.1 Total Resistance

As specified in paragraph 1.7.1.

1.8.2 Thermal Shock

Resistors shall be tested in accordance with Method 107 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter - B.

b. Measurement before cycling - Total resistance shall be measured as specified in 1.8.1. For setting stability the contact arm shall be set at approximately 40 per cent of the actual effective-electrical travel. An adequate DC test potential shall be applied between the end terminals. The voltage between the end terminals, and the voltage between one end terminal and the contact arm, shall be measured and applied to the following formula:

$$\text{Setting stability in per cent} = \frac{E_1 \times 100}{E_2}$$

Where:

E_1 = Voltage across one end terminal and the contact-arm terminal.

E_2 = Voltage across the end terminals.

The difference between the initial measurement made before the environmental test and the measurement made after the test indicates the per cent change.

c. Measurements after cycling - Setting stability and total resistance shall be measured as specified in (b). Continuity of the contact arm shall be verified by connecting a vacuum-tube voltmeter or other suitable indicating device, between the contact-arm terminal and the counterclockwise end terminal. The applied voltage shall be in accordance with Table X.

d. Examination after test - Resistors shall be examined for evidence of mechanical damage.

TABLE X

DC RESISTANCE TEST VOLTAGE

Total resistance, nominal (Ohms)	Maximum test voltage (Volts)
100	1.0
Over 100 to 1,000	3.0
Over 1,000 to 10,000 incl	10.0
Over 10,000 to 0.1 meghom, incl . .	30.0
Over 0.1 megohm	100.0

1.8.3 Burn-In

As specified in paragraph 1.7.3.

1.8.4 Contact-Resistance Variation

Contact resistance variation shall be measured with the measuring circuit shown on Figure B-3, or its equivalent. During this test, the lead screw shall be rotated in both directions for a total of 3 cycles, through 90 per cent of the actual effective-electrical travel, at the rate of 1 cycle for 5 seconds, minimum, to 2 minutes, maximum. Contact-resistance variation shall be defined as any abrupt change from one contact-resistance level to another, exclusive of the roll-on or roll-off points where the contact arm moves from the termination onto, or off, the resistance element.

R_X - Test specimen

Oscilloscope bandwidth: 100 hertz to 50 kilohertz

Minimum input impedance: At least 10 times the nominal resistance being tested.

NOTE: At the calibration of the decade, terminals 1 and 2 must be coincident. Calibration decade is to be set for the contact-resistance (CRV) level of the specific nominal resistance being tested.

FIGURE B-3. CONTACT-RESISTANCE-VARIATION MEASURING CIRCUIT

1.8.5 Insulation Resistance

As specified in paragraph 1.7.4.

1.9 THERMISTOR, (THERMALLY SENSITIVE RESISTOR), INSULATED

1.9.1 Zero-power Resistance

a. Temperature - All resistance measurements shall be made in a controlled uniform medium capable of maintaining an accuracy in temperature of:

(1) $\pm$ 0.01°C for beads, beads in rods, and beads in probes.

(2) $\pm$ 0.05°C for all other types.

b. Equipment - A wheatstone bridge or equivalent, accurate to $\pm$ 0.05 per cent or better.

c. Mounting - Thermistors shall be mounted by normal mounting means in corrosion resistant clips mounted on a 1/8 inch diameter brass rod.

(1) Beads - Flat non-corrosion clips shall be used. The leads shall be gripped 1/4 $\pm$ 1/16 inch from the end of the thermistor body.

(2) All other types - Use suitable corrosion-resistant clips. The leads shall be gripped 1 $\pm$ 1/16 inch from the end of the thermistor body.

d. Test procedure - Zero-power resistance shall be measured at 25°C and 125°C. With the input voltage source disconnected, the output indicator shall be adjusted to the zero output position. The input voltage source shall be connected, the zero-power resistance measured and the power source disconnected. The output shall return to the initial zero output position $\pm$ 0.05%.

1.9.2 Burn-In

a. Initial measurement - Obtain zero-power resistance at 25°C.

b. Mount - As specified in paragraph 1.9.1.c.

c. Operating Condition - Provide filtered regulated DC or battery power sufficient to raise the thermistor to the maximum power rating. The circuit shall be energized for 100^{+1}_{-0} hours at ambient room temperature.

d. Measurement after burn-in - Sixty minutes after removal from the circuit, the thermistors shall be subjected to a zero-power resistance measurement.

[redacted]

e. Examination after burn-in - Thermistors shall be examined for evidence of arcing, burning or charring.

1.9.3 Thermal Shock

Thermistors shall be tested in accordance with Method 107 of Standard MIL-STD-202. The following details and exceptions shall apply:

a. Test condition letter:

(1) B - for thermistors rated at 125°C.

(2) C - for thermistors rated at 200°C.

(3) C - for thermistors rated at 275°C, except maximum temperature shall be 275°C.

b. Operating condition - Each thermistor shall be subjected to 10 cycles of thermal shock performed continuously.

c. Measurements - Zero-power resistance shall be measured at 25°C before and after cycling. The change in zero-power resistance shall not exceed ± 2%.

1.9.4 Resistance - Temperature Characteristic

Each resistor shall be stabilized at each of the ambient temperatures listed in Table XI. Zero-power resistance shall be made at each specified temperature after a stabilization time equal to or not less than ten times the applicable thermal time constant. Resistance shall be tabulated for each measurement.

TABLE XI

RESISTANCE-TEMPERATURE CHARACTERISTICS

Sequence	Temperature	F (±per cent)	G (±per cent)	J (±per cent)	K (±per cent)
1	-55	10	12	15	20
2	-15	5	6	9	14
3	0	3	4	7	12
4	25	1	2	5	10
5	50	3	4	7	12
6	75	5	6	9	14
7	100	7	9	12	17
8	125	10	12	15	20
9	200[1]	15	18	25	30
10	275[1]	20	25	35	40

[1] These temperatures not applicable to all styles.

1.9.5 X-Ray

Per MSFC-STD-335.

1.10 VISUAL AND MECHANICAL

Examine each resistor to verify that the material, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements. After all tests required by Tables I, II or III have been completed, each resistor shall be examined for evidence of damage, arcing, breakdown, seal leaks and integrity of marking.

1.11 SCREENING IDENTIFICATION SYMBOL

After successful completion of all the applicable screening requirements of this appendix, each resistor shall be marked with a screening identification symbol. The screening identification symbol shall be an "S" and shall precede the part number.

APPENDIX C

MINIMUM SCREENING REQUIREMENTS FOR RELAYS

1.0 RELAY SCREENING

Relay screening shall be accomplished in accordance with the following requirements. Each relay shall pass all tests.

1.1 VISUAL INSPECTION (INTERNAL)

Internal visual inspection immediately prior to sealing should be accomplished, if at all possible, as specified in MSFC-SPEC-339A.

1.2 VIBRATION SCAN

Relays for use in critical application should be subjected to vibration scan as specified in paragraph 4.10.5.6.1 of MSFC-SPEC-339A.

1.3 LOW LEVEL RUN-IN

Per paragraph 4.10.8 of MSFC-SPEC-339A.

1.4 INSULATION RESISTANCE

Per paragraph 4.10.2 of MSFC-SPEC-339A.

1.5 DIELECTRIC STRENGTH

Per paragraph 4.10.3.1 of MSFC-SPEC-339A.

1.6 SEAL LEAKAGE (HERMETICALLY SEALED RELAYS)

Per paragraph 4.10.4 of MSFC-SPEC-339A.

1.7 ELECTRICAL CHARACTERISTICS

Per paragraph 4.10.6 of MSFC-SPEC-339A.

1.8 RADIOGRAPHIC INSPECTION

Per paragraph 4.10.10 of MSFC-SPEC-339A.

1.9 VISUAL INSPECTION (EXTERNAL)

Per paragraph 4.10.1.2 of MSFC-SPEC-339A.

NOTE: Where the electrical characteristics for relays specified in MSFC-SPEC-339A are not applicable, the manufacturer's specifications or contractor's design requirements should be the criteria.

2.1 SCREENING IDENTIFICATION SYMBOL

After successful completion of all the screening requirements of this appendix, each relay shall be marked with a screening identification symbol. The screening identification symbol shall be an "S" and shall precede the part number.

APPENDIX D

MINIMUM SCREENING REQUIREMENTS FOR ELECTROMAGNETICS PARTS

1.0 ELECTROMAGNETIC PART SCREENING

The screening level of electromagnetic parts shall be as follows:

a. All encapsulated, potted or hermetic sealed electromagnetic parts which pass all applicable tests specified in Table I shall be considered to be level one screened (1S) parts.

b. Encapsulated, potted or hermetic sealed electromagnetic parts that have been sealed prior to the screening inspection shall not be subjected to the internal visual inspection (paragraph 1.1.1). These parts that pass all other applicable tests specified in Table I shall be considered to be level two screened (2S) parts.

c. All open type electromagnetic parts which pass all applicable tests specified in Table I shall be considered to be level two screened (2S) parts.

1.1 VISUAL INSPECTION

1.1.1 Visual Inspection (Internal)

Internal visual inspection shall be performed under 10X or greater magnification. This inspection shall be performed on (1S) parts immediately prior to final wrapping, sealing or encapsulation of parts, (see 2.1). The materials, internal design and construction, and dimensions shall be as specified in applicable documentation. The inspection shall include but not necessarily be limited to the verification of the following:

a. Minimum clearances and maximum outside dimensions of subassemblies.

b. Proper winding techniques and assembly of windings to cores, mounting brackets and terminal boards, and absence of cuts, breaks, or abrasions in coil winding insulation.

c. Proper impregnation (Check for air bubbles, proper curing, voids or lack of impregnation) when impregnation is required.

d. Correct length and absence of kinks in lead wires and absence of cracks, breaks or cuts in coil lead wire insulation.

e. Absence of solder flux and other foreign materials.

TABLE 1

Electromagnetic Part Type	Visual Internal See 2.1	X-Ray	Dielectric Strength	Induced Voltage	Insulation Resistance	Electrical Characteristics	Thermal Shock	Burn-In	Scaling	Visual, External	Screening Identification
Power & Audio Transformers and Inductors											
Open Type	N/A	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	N/A	N/A	2.1.2
Encapsulated or Potted	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	1.9.2	1.1.2	1.1.1 or 1.1.2
Hermetic Sealed	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	1.9.1 & 1.9.2	1.1.2	2.1.1 or 2.1.2
Pulse Transformers											
Open Type	N/A	1.2	1.3.1	1.4 1	1.5	1.6	1.7	1.8	N/A	1.1.3	2.1.2
Encapsulated or Potted	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	1.9.2	1.1.2	2.1.1 or 2.1.2
Hermetic Sealed	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	1.9.1 & 1.9.2	1.1.2	2.1.1 or 2.1.2
RF & LF Transformers											
Open Type	N/A	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	N/A	1.1.3	2.1.2
Encapsulated or Potted	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	1.9.2	1.1.2	2.1.1 or 2.1.2
Hermetic Sealed	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.3	1.9.1 & 1.9.2	1.1.2	2.1.1 or 2.1.2
Radio Interference Filters											
Encapsulated or Potted	1.1.1	1.2	1.3.2	N/A	1.5	1.6	1.7	1.8	1.9.2	1.1.2	2.1.1 or 2.1.2
Hermetic Sealed	1.1.1	1.2	1.3.2	N/A	1.5	1.6	1.7	1.8	1.9.1 & 1.9.2	1.1.2	2.1.1 or 2.1.2
High Pass, Low Pass, Band Pass, Band Suppression, Dual Function Filters											
Encapsulated or Potted	1.1.1	1.2	1.3.2	N/A	1.5	1.6	1.7	1.8	1.9.2	1.1.2	2.1.1 or 2.1.2
Hermetic Sealed	1.1.1	1.2	1.3.2	N/A	1.5	1.6	1.7	1.8	1.9.1 & 1.9.2	1.1.2	2.1.1 or 2.1.2
Coils, RF, LF, Transformers RF, Microelements, Inductive											
Open Type	N/A	1.2	1.3.1	N/A	1.5	1.6	1.7	1.8	N/A	1.1.3	2.1.2
Encapsulated or Potted	1.1.1	1.2	1.3.1	N/A	1.5	1.6	1.7	1.8	1.9.2	1.1.2	2.1.1 or 2.1.2
Coils, Tube Deflection; Focusing											
Open Type	N/A	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	N/A	1.1.3	2.1.2
Encapsulated or Potted	1.1.1	1.2	1.3.1	1.4.2	1.5	1.6	1.7	1.8	1.9.2	1.1.2	2.1.1 or 2.1.2

NOTE: When specified by MSFC Electromagnetic Parts shall be subjected to the corona test specified in paragraph 1.3.3.

Any part which does not meet the requirements listed above shall be rejected from the lot. Rejected parts may be reworked with prior approval of the procuring activity.

1.1.2 Visual Inspection, Hermetic Sealed and Potted (External)

Hermetically sealed and potted electromagnetic parts shall be examined visually under at least 7X magnification for quality of workmanship and mechanical soundness, including such factors as seal weld, coating, voids in casting, plating, terminals, numbering of terminals, and product marking. Any cracks, blisters, or any other imperfections affecting operating characteristics, or fit, form, or function of the part shall be cause for rejection of the parts. The materials, external design and construction, dimensions, and weight shall be as specified in applicable documentation.

1.1.3 Visual Inspection, Open Type (External)

Open type-electromagnetic parts shall be inspected visually using 10X or greater magnification as necessary. The inspection shall include but not necessarily be limited to verification of the following:

a. Maximum outside dimensions, uniformity of coil windings.

b. Proper winding techniques and assembly of windings to cores, mounting brackets and terminal boards.

c. Correct length and absence of kinks in lead wires and absence of cracks, break, and cuts in coil lead wire insulation.

d. Absence of solder flux and other foreign materials.

e. Quality of workmanship and materials.

f. Product marking.

g. Absence of any imperfections affecting operating characteristics, or fit, form, or function of the part.

h. Check unimpregnated parts for overlap of coil insulation, and cuts or breaks in coil winding insulation.

Any part failing to meet the requirements specified above may be reworked with prior approval of the procuring activity

1.2 RADIOGRAPHIC INSPECTION

Electromagnetic parts shall be subjected to radiographic inspection as specified in Standard MSFC-STD-355, to determine conformance of internal construction to applicable documentation. Open type electromagnetic parts require only one X-Ray view through thinnest plane.

1.3 DIELECTRIC STRENGTH TEST

1.3.1 Dielectric Strength of Electromagnetic Parts (Except Filters)

1.3.1.1 Atmospheric pressure - Parts shall be tested in accordance with Method 301 of Standard MIL-STD-202. The following details shall apply:

a. The part shall be placed on a metal plate (ground) or V block as applicable.

b. The magnitude of the AC test voltage shall be as specified in Table II.

c. The test voltage shall be applied for 60^{+0}_{-10} seconds.

d. Points of measurements - between insulated points and the case or ground.

e. The rate of application of test voltages greater than 1000 volts shall not exceed 500 volts rms per second.

During the test there shall be no arcing, flashover, breakdown of insulation or evidence of damage.

TABLE II

TEST REQUIREMENTS, DIELECTRIC STRENGTH (See Note 1)

Working Voltage (See Note 2)		AC Test Voltage (rms) (See Note 3)	
Greater Than	Up to and Including	Atmospheric Pressure	Barometric Pressure
0 V	50 V	100	100
50 V	100 V	300	300
100 V	175 V	500	300
175 V	700 V	2.8 x Working Voltage	1.3 x Working Voltage whichever is greater
700 V	---	1.4 x Working Voltage + 1000	

NOTES: Table II

1. The requirements contained in this table are minimum requirements. If applicable procurement document specifies a higher test voltage, that voltage shall be used.

2. The working voltage is defined as the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered. This insulation may be between windings or between a winding and the case or core.

3. The rms test voltages specified shall be used for the initial test only. It the part has previously been subjected to this dielectric strength voltage, all re-testing of dielectric strength shall be at 90 per cent of the values specified.

1.3.1.2 Barometric Pressure (Reduced) - Electromagnetic parts shall be tested in accordance with Method 105 of MIL-STD-202. The following details shall apply:

a. This test required on flight parts not previously qualified to this test. Two samples of each part type from each shipment shall be tested.

b. Test condition C.

c. The magnitude of test voltage shall be as specified in Table II.

1.3.2 Dielectric Strength of Filters

1.3.2.1 Atmospheric Pressure - Parts shall be tested in accordance with Method 301 of MIL-STD-202. The following details and exceptions shall apply:

a. The part shall be placed on a metal plate (Ground) or "V" Block as applicable.

b. The magnitude of the test voltage shall be as specified in Table III.

TABLE III

FILTER DIELECTRIC STRENGTH

Rated Voltage		Test Voltage	
Greater Than	Up to and Including	Atmospheric Pressure	Barometric Pressure
0 Vdc	100 Vdc	200 Vdc	1.25 x rated Voltage dc
100 Vdc	- - - -	2 x rated Voltage dc	
0 Vac rms	50 Vac rms	100 Vac rms	1.25 x Rated Voltage, rms
50 Vac rms	100 Vac rms	300 Vac rms	
100 Vac rms	175 Vac rms	500 Vac rms	
175 Vac rms		2.8 x rated Voltage rms	

c. The test voltage shall be applied for $60 \, ^{+0}_{10}$ seconds.

d. Points of application of test voltage - between the case (ground) and all insulated points and between all mutually insulated points.

e. Limiting value of surge current - a current limiting resistor shall be connected in series with the filter to limit the surge current to the maximumrrated current or 1 ampere whichever is less.

During the test there shall be no arcing, flashover, breakdown of insulation or evidence of damage.

1.3.2.2 Barometric Pressure (Reduced) - Electromagnetic parts shall be tested in accordance with Method 105 of MIL-STD-202. The following details shall apply:

a. This test required on flight parts not previously qualified to this test. Two samples of each part type from each shipment shall be tested.

b. Test condition C.

c. The magnitude of the test voltage shall be as specified in Table III.

1.3.3 Corona

When specified, electromagnetic parts shall be tested for corona. The following details shall apply:

a. Each part shall be subjected to the barometric test of paragraph 1.3.1.2 of 1.3.2.2 as applicable.

b. The level of corona as indicated on the oscilloscope shall not exceed 1 inch peak-to-peak with the scope sensitivity set at 0.1V peak-to-peak per inch at the test voltage and pressure specified in 1.3.1.2 or 1.3.2.2.

c. The test circuits shall be one of those shown in Figure 9 of MI -T-‸7-C.

1.4 INDUCED VOLTAGE

Only those parts having at least one terminal voltage in excess of 25 volts shall be subjected to this test.

1.4.1 Pulse Type Parts

Induced voltage test of pulse type electromagnetic parts shall be accomplished by applying to any winding the following pulse voltage:

a. Amplitude - two times rated voltage.

b. Repetition rate specified for unit under test.

c. Pulse width - sufficient to induce a voltage, across any winding, greater than 25 per cent but less than 50 per cent of rated pulse width.

d. Duration of test voltage - one minute.

During the time the test voltage is applied there shall be no continuous arcing, breakdown of insulation, nor shall there be any abrupt changed in input current.

1.4.2 Other Parts

Induced voltage test of electromagnetic parts, other than pulse type parts, shall be accomplished by applying to any winding the following voltage:

a. Amplitude - sufficient to cause twice the rated voltage to appear across any winding (minimum test voltage shall be 100V).

b. Frequency - Not less than twice the operating frequency.

c. Duration of test voltage - 5 seconds.

During the time the test voltage is applied there shall be no continuous arcing, breakdown insulation, nor shall there be any abrupt changes in input current or changes in Q, as applicable.

1.5 INSULATION RESISTANCE

Electromagnetic parts shall be tested in accordance with Method 302 of MIL-STD-202. The following details shall apply:

a. Test voltage shall be as specified in Table IV.

b. The part shall be placed on a metal plate (ground) V Block as applicable.

c. Points of measurement - Between all mutually insulated points, and between insulated points and the metal plate, "V" Block, case or ground.

a. The insulation resistance shall be as specified in Table IV.

TABLE IV

INSULATION RESISTANCE TEST (See Note 1)

Working Voltage (See Note 2)		Insulation Resistance	
Greater Than	Up to and Including	Test Voltage	Minimum Insulation Resistance (Megohms)
0 V	50 V	100 Vdc	500
50 V	100 V	100 Vdc	1000
100 V	175 V	300 Vdc	7500
175 V	700 V	500 Vdc	7500
700 V	---	1000 Vdc	10,000

NOTES: Table IV

1. The requirements contained in this table are minimum requirements. If applicable procurement document specifies a higher test voltage or higher insulation resistance, or both, then the higher requirement, or requirements, shall be used.

2. The working voltage is defined as the maximum instantaneous voltage stress that may appear under normal rated operation across the insulation being considered. This insulation may be between windings or between a winding and the case or core.

1.6 ELECTRICAL CHARACTERISTICS

Each electromagnetic part shall be subjected to all electrical characteristic tests specified for acceptance testing in the applicable specification as shown in Table V. Tests which are repeats of tests already performed during screening need not be made.

TABLE V

ELECTRICAL CHARACTERISTICS

Type Part	Test Specification
Transformers and inductors, audio power and high power pulse;	MIL-T-27
Transformers, pulse, low power	MIL-T-21038
Coils and transformers, intermediate and radiofrequency	MIL-C-15305
Filters, radio interference	MIL-F-15733
Filters, high pass, low pass, band pass, band suppression and dual functioning;	MIL-F-39025
Coils and transformers, intermediate and radiofrequency microelements, inductive	MIL-C-55189
Coils, tube deflection; and coils, tube focusing	MIL-C-18388

1.7 THERMAL SHOCK

Electromagnetic parts shall be tested in accordance with Method 107 of Standard MIL-STD-202.

1.7.1 Details

The following details shall apply:

a. Test condition letter B.

b. Monitoring during cycling - Voltages or currents shall be monitored during thermal shock with a device capable of detecting and indicating discontinuities greater than 10 microseconds in duration. The inductance of all inductors may be monitored during thermal shock.

1.7.2 Rejection
Parts shall be rejected for the following reasons:

a. Winding discontinuities.

b. Fluctuations in inductance observed during thermal shock.

c. Evidence of physical damage such as cracks, bursting or bulging of parts observed during thermal shock.

1.8 BURN-IN

1.8.1 Burn-in Cycling

Electromagnetic parts shall be subjected to five burn-in cycles totaling 168 hours (one week). Four of the cycles shall consist of 20 hours during which time the part shall be operated at maximum operating temperature with loading equal to or greater than rated AC and DC voltages and currents and maximum and maximum rated pulse duration when applicable, followed by 4 hours at room ambient temperature without excitation. The fifth cycle shall be 68 hours at maximum operating temperature with parts loaded as before and 4 hours without excitation at room ambient temperature. For transformers only, test may be performed with parts loaded back-to-back provided the above mentioned loading requirements are met. This test may be performed at any ambient temperature and with any temperature rise provided that the maximum operating temperature of the part is held within $^{+10}_{-55}$°C and no drafts or varying air velocities are present. At the option of the test facility, the voltage may be increased to at least 1.2 times the rated voltage so that the maximum operating temperature is attained.

1.8.1.1 Open Type Parts Post Cycling Procedure

Upon completion of cycling the parts shall be subjected to the following procedure:

1. Cool 12 hours in a vacuum.

2. Test as specified in 10.3, 10.4, 10.5 (See Note 3, Table II) and 10.6 in an atmosphere in which the relative humidity does not exceed 45 per cent.

3. Visually inspect part to paragraph 10.1.3 in the atmosphere specified in (2) above.

4. Seal each part individually in a package provided with a dessicant.

NOTE

It is recommended that the part remain in this package until it is installed in the next higher assembly and that the next higher assembly be prebaked at 85°C for at least 4 hours prior to encapsulation, to insure that parts are free from moisture.

1.8.1.2 Other Parts Post Cycling Procedure - Upon completion of cycling, the parts shall be tested as specified in 1.9.

1.9 SEALING

1.9.1 Fine Leak Test

Hermetically sealed electromagnetic parts shall be tested in accordance with Method 112 of MIL-STD-202, test condition C, procedure III.

1.9.2 Gross Leak Test

Metal encased and encapsulated electromagnetic parts shall be immersed for 4 to 5 minutes in a water bath maintained at a temperature of $85^{\circ}\,{}^{+5}_{-5}\,^{\circ}C$. The temperature of the part shall not exceed 40°C at the time of immersion. There shall be no continuous flow of air bubbles or leakage of compound from the part body. After removal from the bath the part shall be dried for 2 hours at 25°C and then tested as specified in 1.3, 1.4, 1.5 (See Note 3, Table II, and 1.6). These tests shall be applied to the part as soon as possible after drying and shall be completed no later than 4 hours after removal from the water bath.

2.1 SCREENING IDENTIFICATION SYMBOL

After successful completion of the screening requirements of this appendix, each electromagnetic part shall be marked with a screening identification symbol.

2.1.1 Level One Screening (1S)

Each electromagnetic part considered to be a level one screened part (1S)(See paragraph 1.0, a) shall be marked "1S".

2.1.2 Level Two Screening (2S)

Each electromagnetic part considered to be a level two screened part (2S)(See paragraph 1.0, b and c) shall be marked "2S".